and 2.2 W/kg exposure, while in the second experiment the incidence at 1.4 W/kg was significantly reduced.

The experiment by Anane et al. [25] is inconclusive not only because of the divergent results of the two experiments at the same exposure condition (1.4 W/kg SAR) but mainly because of the insufficient size of experimental groups. With a 70% background tumor incidence as observed in this investigation even for an increase to 100% in the exposed group the power to detect this difference at a significance level of 5% is less than 60%. Furthermore, considering experimental and biological variation substantial differences may occur by chance simply due to different distribution of background risk between experimental groups. Therefore, in contrast to the statement of authors that relevant differences would be detected with 16 animals per group, the study was severely underpowered and prone to spurious effects from uneven distribution of background risk. Also stress from confinement of animals could have contributed to the ambiguous results.

Yurekli et al. [26] report an experiment in male Wistar albino rats with the aim to analyze oxidative stress from whole-body exposure to a GSM 945 MHz signal at a SAR level of 11.3 mW/kg. In a gigahertz transverse (GTEM) cell a base station exposure in the far field was simulated. Two groups of rats, 9 animals in each group, were either exposed 7 h a day for 8 days or sham exposed. At the end of the exposure blood was withdrawn and malondialdehyde (MDA), reduced glutathione (GSH), and superoxide dismutase (SOD) were measured. MDA as well as SOD was significantly increased after exposure compared to sham, while GSH was significantly reduced. These results indicate that exposure may enhance lipid peroxidation and reduce the concentration of GSH which would increase oxidative stress. A disadvantage in this experiment was that the experiments were carried out sequentially and therefore animals differed in weight and no blinding could be applied.

In a series of experiments conducted in the Kashima Laboratory, Kamisu, Japan, different in vitro assays were applied to test whether irradiation with 2.1425 GHz, which corresponds to the middle frequency allocated to the down-link signal of IMT-2000 (International Mobile Telecommunication 2000, a 3G wide-band CDMA system), leads to cellular responses relevant for human health [27–29]. In the first experiment phosphorylation and gene expression of p53 was assessed [27]. In the second experiment heat-shock protein expression was evaluated in the human glioblastoma cell line A172 and human IMR-90 fibroblasts [28]. The effect of exposure of BALB/T3T cells on malignant transformation, on promotion in MCA (3-methylcholanthrene) treated cells, and on co-promotion in cells pretreated with MCA and co-exposed to TPA (12-O-tetradecanoylphorbol-13-acetate) was investigated by Hirose et al. [29]. In none of these experiments applying the same exposure regimen but different intensities and exposure durations (80 mW/kg SAR up to 800 mW/kg SAR, 2 h to several weeks) an effect of exposure was observed. Exposure facility comprised of two anechoic chambers allowing blinded simultaneous exposure of an array of 7 × 7 dishes in each chamber. Dishes were placed in a culture cabinet located in the anechoic chamber and exposed to radiation from a horn antenna whose signals were focused by a dielectric lens to obtain homogenous irradiation of the dishes. Details of the exposure protocol were not disclosed. It is stated that an IMT-2000 signal at a chiprate (a chip is a byte of information) of 3.84 Mcps was used for exposure. Assuming that it did not contain any low-frequency components as typically present in actual exposures the implications of the findings are unclear. It is rarely supposed that the high-frequency components of RF-EMFs itself are able to elicit any relevant effects in the 'low-dose' range. Rather low-frequency modulation may contribute to biological responses. Therefore, results of these Japanese investigations are of limited value for risk assessment, conditional on them having no such biologically relevant exposure attributes.

4. Discussion

Although there is considerable public concern about adverse health effects from long-term exposure to microwaves from mobile phone base stations there are only few studies addressing this issue. Several reasons can be identified for the scarcity of scientific investigations. First of all, WHO has discouraged studies of base stations, at least concerning cancer as endpoint, because retrospective assessment of exposure was considered difficult. Also COST 281 did not recommend studies of base stations and stated in 2002: "If there is a health risk from mobile telecommunication systems it should first be seen in epidemiological studies of handset use."

It is not appreciated that there are substantial and important differences between exposure to handsets and base stations. The typically very low exposure to microwaves from base stations, rarely exceeding 1 mW/m^2, was deemed very unlikely to produce any adverse effect. Assuming energy equivalence of effects a 24 h exposure at 1 mW/m^2 from a base station would be roughly equivalent to 30 min exposure to a mobile phone operating at a power of 20 mW (average output power in areas of good coverage). Because we do not know whether time-dose reciprocity holds for RF-EMF and whether there is a threshold for biological effects, there is no a priori argument why such low exposures as measured in homes near base stations could not be of significance for wellbeing and health. As an example from a different field of environmental health consider noise exposure: it is well known that at noise levels exceeding 85 dB(A) a temporary shift of hearing threshold occurs and that, besides this short-term effect, after years of exposure noise induced hearing loss may occur. On the other hand, at a sound pressure of more than a factor of 1000 below, when exposure occurs during the night, exposed individuals will experience sleep disturbances that could affect health in the long run. From this example it follows that exposure may have qualitatively different effects at different exposure levels.

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The most important difference between mobile phone use and exposure from base station signals is duration of exposure. While mobile phones are used intermittently with exposure duration seldom exceeding 1 h per day, exposure to base stations is continuous and for up to 24 h a day. It has also to be mentioned that the exposure of mobile phone users is in the near field and localized at the head region, while base stations expose the whole body to the far field. Strictly speaking exposure from mobile phones and their base stations have almost nothing in common except for the almost equal carrier frequency that is likely of no importance for biological effects.

Concerning reconstruction of exposure to base station signals there is no greater difficulty than for retrospective assessment of exposure to mobile phones. It is not always necessary to determine exposure precisely. For epidemiological investigations it often suffices to have a certain gradient of exposures. As long as any two persons can be differentiated along such a gradient epidemiological investigations can and should be carried out.

There are seven field studies of wellbeing and exposure to base station signals available to date. Two were in occupational groups working in a building below [11] or below as well as opposite a building with a roof-mounted base station antenna [10]. The other five were in neighbors of base stations: Santini et al. [5,6], Navarro et al. [8], Hutter et al. [9], Blettner et al. [7], and Thomas et al. [12]. Studies had different methodologies with the least potential for bias in the studies of Hutter et al. [9] and Blettner et al. [7]. All other studies could be biased due to self-selection of study participants. One study explored personal dosimetry during 24 h [12] but results were inconclusive due to insufficient power and omission of nighttime measurements. The study of Blettner et al. [7] had an interesting design with a first phase in a large population based representative sample and a second phase with individual measurements in the bedrooms of participants that were a subgroup of the larger sample. Unfortunately this second sample did not contain a sufficiently large fraction of individuals with relevant exposure (99% had bedside measurements below 0.3 mW/m^2).

Despite some methodological limitations of the different studies there are still strong indications that long-term exposure near base stations affects wellbeing. Symptoms most often associated with exposure were headaches, concentration difficulties, restlessness, and tremor. Sleeping problems were also related to distance from base station or power density, but it is possible that these results are confounded by concerns about adverse effects of the base station, or more generally, by specific personality traits. While the data are insufficient to delineate a threshold for adverse effects the lack of observed effects at fractions of a mW/m^2 power density suggests that, at least with respect to wellbeing, around 0.5–1 mW/m^2 must be exceeded in order to observe an effect. This figure is also compatible with experimental studies of wellbeing that found effects at 2.7 and 10 mW/m^2.

There are regular media reports of an unusually high incidence of cancer in the vicinity of mobile phone base stations. Because there are several hundred thousand base stations operating all over the world some must coincide by chance with a high local cancer incidence. Regionally cancer incidence has a distribution with an overdispersion compared to the Poisson distribution. Overdispersion is predominantly due to variations in the distribution of age and gender. Therefore, a much higher number of cases than expected from average incidences can occur by chance. Unfortunately there are no multi-regional systematic investigations of cancer incidence related to mobile phone base stations available to date. Only studies in a single community, one in Bavaria [14] and one in Israel [15], have been published that reported a significantly increased incidence in an area of 400 and 350 m around a base station, respectively. Although incidence in proximity to the base station strongly exceeded the expected values and was significant even considering overdispersion in the case of the Neila study in Bavaria, still no far reaching conclusions can be drawn due to the ecological nature of the studies. However, both studies underline the urgent need to investigate this problem with an appropriate design. Neubauer et al. [30] have recommended focusing initially on short-term effects and 'soft' outcomes given the problems of exposure assessment. However, as has been mentioned previously, the problems of exposure assessment are less profound as often assumed. A similar approach as chosen in the study of leukemia around nuclear power plants [31] could be applied also for studying cancer in relation to base station exposure. Such a case–control design within areas around a sufficiently large sample of base stations would provide answers to the questions raised by the studies of Eger et al. [14] and Wolf and Wolf [15].

In 2003 the so-called TNO study [19] had received wide publicity because it was the first experimental investigation of short-term base station exposure in individuals that rated themselves sensitive to such signals. A lot of unfounded criticism was immediately raised such as complaints about the limited sample size and the not completely balanced design. But also valid arguments have been put forward. The consecutive tests with all experimental conditions presented one after the other could result in sequential effects that may not be completely removed by balancing the sequence of exposures. In several countries follow-up studies were initiated two of which have already been published [21,23]. One of these experiments partly supported the TNO study the other found no effect. While the study of Regel et al. [21] closely followed the conditions of the previous experiment only avoiding the shortcomings of a sequential within-day design and improvements by including two intensities of UMTS exposure, the study of Eltiti et al. [23] had a different procedure and included physiological measurements. Regel et al. [21] applied the same questionnaire as has been used in the TNO study. Because non-sensitive participants and sensitive participants during sham exposure (despite their almost 10 years younger age) reported considerably lower wellbeing,

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it is possible that the experimental setup was more adverse and imposed too much stress such that these conditions confounded the effect of the base station exposure. Results of the other replication experiment of Eltiti et al. [23] may be compromised by an imbalance in the sequence of experiments with more sensitive participants receiving UMTS exposure in the first session. Hence, based on available evidence, it cannot be firmly decided whether such weak signals as applied in these experiments to simulate short-term base station exposure affects wellbeing.

Concerning animal experiments and in vitro investigations the data base is insufficient to date. While in vivo exposure of Wistar albino rats [26] imply an induction of oxidative stress or an interaction with antioxidant cellular activity, in vitro experiments [27] found no indication of cellular stress in human glioblastoma cells and fibroblasts. While some may be inclined to attribute effects in the low-dose range to experimental errors there is the possibility that the characteristics of the exposure that are relevant for an effect to occur simply vary in the experiments and lead to ambiguous results. As long as these decisive features of the exposure (if they actually exist) are unknown and in particular the type and components of low-frequency modulation vary across experiments, it is impossible to coherently evaluate the evidence and to come to a science based conclusion.

Overall results of investigations into the effects of exposure to base station signals are mirroring the broader spectrum of studies on handsets and on RF-EMF in general. There are indications from epidemiology that such exposures affect wellbeing and health weakly supported by human provocation studies and an inconclusive body of evidence from animal and in vitro studies.

References

[1] N. Leitgeb, J. Schröttner, M. Böhm, Does “electromagnetic pollution” cause illness? An inquiry among Austrian general practitioners, Wien. Med. Wochenschr. 155 (9–10) (2005) 237–241.

[2] A. Huss, M. Röösli, Consultations in primary care for symptoms attributed to electromagnetic fields—a survey among general practitioners, BMC Public Health 30 (6) (2006) 267.

[3] M. Kundi, F. Schinner, W. Mosgöller, H.-P. Hutter, Proceedings of the International Workshop on Possible Biological and Health Effects of RF Electromagnetic Fields, 25–28 October, University of Vienna, 1998.

[4] WHO 2006, WHO Research Agenda for Radio Frequency Fields.

[5] R. Santini, P. Santini, J.M. Danze, P. Le Ruz, M. Seigne, Enquête sur la santé de riverains de stations relais de téléphonie mobile: I/Incidences de la distance et du sexe, Pathol. Biol. (Paris) 50 (2002) 369–373.

[6] R. Santini, P. Santini, J.M. Danze, P. Le Ruz, M. Seigne, Enquête sur la santé de riverains de stations relais de téléphonie mobile: II/Incidences de l’âge des sujets, de la durée de leur exposition et de leur position par rapport aux antennes et autres sources électromagnétiques, Pathol. Biol. (Paris) 51 (2003) 412–415.

[7] M. Blettner, B. Schlehofer, J. Breckenkamp, B. Kowall, S. Schmiedel, U. Reis, P. Potthoff, J. Schüz, G. Berg-Beckhoff, Querschnittstudie zur Erfassung und Bewertung möglicher gesundheitlicher Beeinträchtigungen durch die Felder von Mobilfunkbasisstationen, BfS (2007).

[8] E.A. Navarro, J. Segura, M. Portoles, C. Gomez-Perretta de Mateo, The microwave syndrome: a preliminary study in Spain, Electromag. Biol. Med. 22 (2003) 161–169.

[9] H.-P. Hutter, H. Moshammer, P. Wallner, M. Kundi, Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations, Occup. Environ. Med. 63 (2006) 307–313.

[10] G. Abdel-Rassoul, O. Abou El-Fatech, M. Abou Salem, A. Michael, F. Farahat, M. El-Batanouny, E. Salem, Neurobehavioral effects among inhabitants around mobile phone base stations, Neurotoxicology 28 (2) (2006) 434–440.

[11] S. Heinrich, A. Ossig, S. Schlittmeier, J. Hellbrück, Elektromagnetische Felder einer UMTS-Mobilfunkbasisstation und mögliche Auswirkungen auf die Befindlichkeit—eine experimentelle Felduntersuchung, Umwelt. Med. Forsch. Prax. 12 (2007) 171–180.

[12] S. Thomas, A. Kühnlein, S. Heinrich, G. Praml, D. Nowak, R. von Kries, K. Radon, Personal exposure to mobile phone frequencies and well-being in adults: a cross-sectional study based on dosimetry, Bioelectromagnetics 29 (2008) 463–470.

[13] K. Radon, H. Spegel, N. Meyer, J. Klein, J. Brix, A. Wiedenhofer, H. Eder, G. Praml, A. Schulze, V. Ehrenstein, R. von Kries, D. Nowak, Personal dosimetry of exposure to mobile telephone base stations? An epidemiologic feasibility study comparing the Maschek dosimeter prototype and the Antennessa SP-090 system, Bioelectromagnetics 27 (2006) 77–81.

[14] H. Eger, K.U. Hagen, B. Lucas, P. Vogel, H. Voit, Einfluss der räumlichen Nähe von Mobilfunksendeanlagen auf die Krebsinzidenz, Umwelt-Medizin-Gesellschaft 17 (2004) 273–356.

[15] R. Wolf, D. Wolf, Increased incidence of cancer near a cellphone transmitter station, Int. J. Cancer Prev. 1 (2004) 123–128.

[16] K. Hansson Mild, M. Repacholi, E. van Deventer, P. Ravazzani (Eds.), 2006. Working Group Report. In: Proceedings International Workshop on EMF hypersensitivity, 25–27 October 2004, Prague, Czech Republic. Milan: WHO Press, pp. 15–26. Available from: http://www.who.int/peh-emf/publications/reports/EHS_Proceedings_June2006.pdf, accessed August 2008.

[17] M. Röösli, Radiofrequency electromagnetic field exposure and non-specific symptoms of ill health: a systematic review, Environ. Res. 107 (2008) 277–287.

[18] N. Leitgeb, J. Schröttner, Electrosensibility and electromagnetic hypersensitivity, Bioelectromagnetics 24 (2003) 387–394.

[19] A.P.M. Zwamborn, S.H.J.A. Vossen, B.J.A.M. van Leersum, M.A. Ouwens, W.N. Mäkel, Effects of Global Communication System Radio-Frequency Fields on Well being and Cognitive Functions of Human Subjects with and without Subjective Complaints. FEL-03-C148, TNO, The Hague, the Netherlands, 2003.

[20] C.J. Bulpitt, A.E. Fletcher, The measurement of quality of life in hypertensive patients: a practical approach, Br. J. Clin. Pharmacol. 30 (1990) (1990) 353–364.

[21] S.J. Regel, S. Negovetic, M. Röösli, V. Berdinas, J. Schuderer, A. Huss, U. Lott, N. Kuster, P. Achermann, UMTS base station like exposure, well being and cognitive performance, Environ. Health Perspect. 114 (2006) 1270–1275.

[22] B. Müller, H.D. Basler, Kurzfragebogen zur Aktuellen Beanspruchung (KAB), Beltz, Weinheim, Germany, 1993.

[23] S. Eltiti, D. Wallace, A. Ridgewell, K. Zougkou, R. Russo, F. Sepulveda, D. Mirshekar-Syahkal, P. Rasor, R. Deeble, E. Fox, Does short-term exposure to mobile phone base station signals increase symptoms in individuals who report sensitivity to electromagnetic fields? A double-blind randomised provocation study, Environ. Health Perspect. 115 (2007) 1603–1608.

[24] M. Röösli, A. Huss, Mobile phone base station exposure and symptoms, Environ. Health Perspect. 116 (2008) A62–A63.

[25] R. Anane, P.E. Dulou, M. Taxile, M. Geffard, F.L. Crespeau, B. Veyret, Effects of GSM-900 microwaves on DMBA-induced mammary gland tumors in female Sprague–Dawley rats, Radiat. Res. 160 (2003) 492–497.

Please cite this article in press as: M. Kundi, H.-P. Hutter, Mobile phone base stations—Effects on wellbeing and health, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.01.008

[26] A.I. Yurekli, M. Ozkan, T. Kalkan, H. Saybasili, H. Tuncel, P. Atukeren, K. Pinar, K. Gumustas, S. Seker, GSM base station electromagnetic radiation and oxidative stress in rats, Electromag. Biol. Med. 25 (2006) 177–188.

[27] H. Hirose, N. Sakuma, N. Kaji, T. Suhara, M. Sekijima, T. Nojima, J. Miyakoshi, Phosphorylation and gene expression of p53 are not affected in human cells exposed to 2.1425 GHz band CW or W-CDMA modulated radiation allocated to mobile radio base stations, Bioelectromagnetics 27 (2006) 494–504.

[28] H. Hirose, N. Sakuma, N. Kaji, K. Nakayama, K. Inoue, M. Sekijima, T. Nojima, J. Miyakoshi, Mobile phone base station emitted radiation does not induce phosphorylation of hsp27, Bioelectromagnetics 28 (2007) 99–108.

[29] H. Hirose, T. Suhara, N. Kaji, N. Sakuma, M. Sekijima, T. Nojima, J. Miyakoshi, Mobile phone base station radiation does not affect neoplastic transformation in BALB/3T3 cells, Bioelectromagnetics 29 (2008) 55–64.

[30] G. Neubauer, M. Feychting, Y. Hamnerius, L. Kheifets, N. Kuster, I. Ruiz, J. Schüz, R. Überbacher, J. Wiart, Feasibility of future epidemiological studies on possible health effects of mobile phone base stations, Bioelectromagnetics 28 (2007) 224–230.

[31] P. Kaatsch, C. Spix, R. Schulze-Rath, S. Schmiedel, M. Blettner, Leukaemia in young children living in the vicinity of German nuclear power plants, Int. J. Cancer 122 (2008) 721–726.

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Review

Long-term exposure to magnetic fields and the risks of Alzheimer's disease and breast cancer: Further biological research

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Abstract

Objective: Extremely low frequency (ELF) and radio frequency (RF) magnetic fields (MFs) pervade our environment. Whether or not these magnetic fields are associated with increased risk of serious diseases, e.g., cancers and Alzheimer's disease, is thus important when developing a rational public policy. The Bioinitiative Report was an effort by internationally recognized scientists who have spent significant time investigating the biological consequences of exposures to these magnetic fields to address this question. Our objective was to provide an unbiased review of the current knowledge and to provide our general and specific conclusions. **Results:** The evidence indicates that long-term significant occupational exposure to ELF MF may certainly increase the risk of both Alzheimer's disease and breast cancer. There is now evidence that two relevant biological processes (increased production of amyloid beta and decreased production of melatonin) are influenced by high long-term ELF MF exposure that may lead to Alzheimer's disease. There is further evidence that one of these biological processes (decreased melatonin production) may also lead to breast cancer. Finally, there is evidence that exposures to RF MF and ELF MF have similar biological consequences. **Conclusion:** It is important to mitigate ELF and RF MF exposures through equipment design changes and environmental placement of electrical equipment, e.g., AC/DC transformers. Further research related to these proposed and other biological processes is required.

Keywords: Extremely low frequency (ELF); Magnetic fields (MFs); Amyloid beta (Aβ); Melatonin; Alzheimer's disease (AD)

Contents

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1. Introduction

In this review, we emphasize (a) two proposed biological models "explaining" the apparent relationship between high, long-term exposure to extremely low frequency (ELF) magnetic fields (MFs) and Alzheimer's disease (AD), one of which also relates to breast cancer and (b) areas of biological research needed to confirm or refute these models. Prior to this discussion, we provide the conclusions from our detailed review chapter (Section 12: Davanipour and Sobel [1]) in the Bioinitiative Report [2] related to epidemiologic research, which initially identified these relationships. We refer the reader to Section 12 and supporting, peer-reviewed papers for details of the epidemiologic studies discussed in that section. Other papers in this issue of Pathophysiology (e.g., on the stress response and DNA strand breaks) demonstrate that exposures to ELF MF and radio frequency (RF) MF often have the same biological consequences.

2. Epidemiologic studies presented in the Bioinitiative Report related to Alzheimer's disease and breast cancer

The conclusions reached from our detailed review of the literature in Section 12 in the Bioinitiative Report (see references for URL) on long-term significant ELF MF exposure and Alzheimer's disease and breast cancer are provided below [1]. The section references below refer to sub-sections of Section 12 of the Bioinitiative Report.

Melatonin production (Section II). Eleven of the 13 published epidemiologic residential and occupational studies are considered to provide (positive) evidence that high long-term ELF MF exposure can result in decreased melatonin production. The two negative studies had important deficiencies which may certainly have biased the results. Thus, there is sufficient evidence to conclude that long-term relatively high ELF MF exposure can result in a decrease in melatonin production. It has not been determined to what extent personal characteristics, e.g., medications, interact with ELF MF exposure in decreasing melatonin production.

2.1. Alzheimer's disease

Section 12 of the Bioinitiative Report provides the details of the following conclusions.

- There is initial evidence that (i) a high level of peripheral amyloid beta, generally considered the primary neurotoxic agent when aggregated, is a risk factor for AD and (ii) medium to high MF exposure can increase peripheral amyloid beta. High brain levels of amyloid beta are also a risk factor for AD and medium to high MF exposure to brain cells likely also increases these cells' production of amyloid beta (Section IIIA).
- There is considerable *in vitro* and animal evidence that melatonin protects against AD. Therefore, it is certainly possible that low levels of melatonin production are associated with an increase in the risk of AD (Section IIIB).
- There is strong epidemiologic evidence that long-term exposure to ELF MF is a risk factor for AD. There are seven studies of ELF MF exposure and AD that met our inclusion criteria. Six of these studies are more of less positive and only one is negative. The negative study has a serious deficiency in ELF MF exposure classification which results in subjects with rather low exposure being considered as having significant exposure. Several published studies were excluded from further consideration due to serious deficiencies, primarily diagnostic inaccuracy (e.g., use of death certificates for diagnosis of AD) and/or serious exposure assessment problems. These latter studies likely had risk estimated seriously biased towards the null hypothesis of no risk. It should be noted, however, that even some of these studies were positive (Sections IIIC and IIID).

2.2. Breast cancer

There is sufficient evidence from *in vitro* and animal studies, from human biomarker studies, from occupational and light at night case-control studies, and the only two longitudinal studies with appropriate collection of urine samples to conclude that high ELF MF exposure may certainly be a risk factor for breast cancer (Section IV). Note that at the time the Bioinitiative Report was made public, there was only one longitudinal study with appropriate collection of urine samples. There are now two such studies [3,4].

Seamstresses. Seamstress is, in fact, one of the most highly ELF MF exposed occupations, with exposure levels generally well above 10 mG over a significant proportion of the workday. Seamstresses have been consistently found to be at higher risk of Alzheimer's disease and breast cancer. This occupation deserves specific attention in future studies. We are unaware of any measurements of RF MF among seamstresses (Section V and throughout Section 12).

3. Biological hypotheses relating ELF MF exposure to Alzheimer's disease and breast cancer

Two biological hypotheses are discussed. The first one relates ELF MF exposure to increased amyloid beta (Aβ) production and subsequent development of AD. The second one relates ELF MF exposure to decreased melatonin production. Decreased melatonin production appears to have differing deleterious consequences related to AD and breast cancer development.

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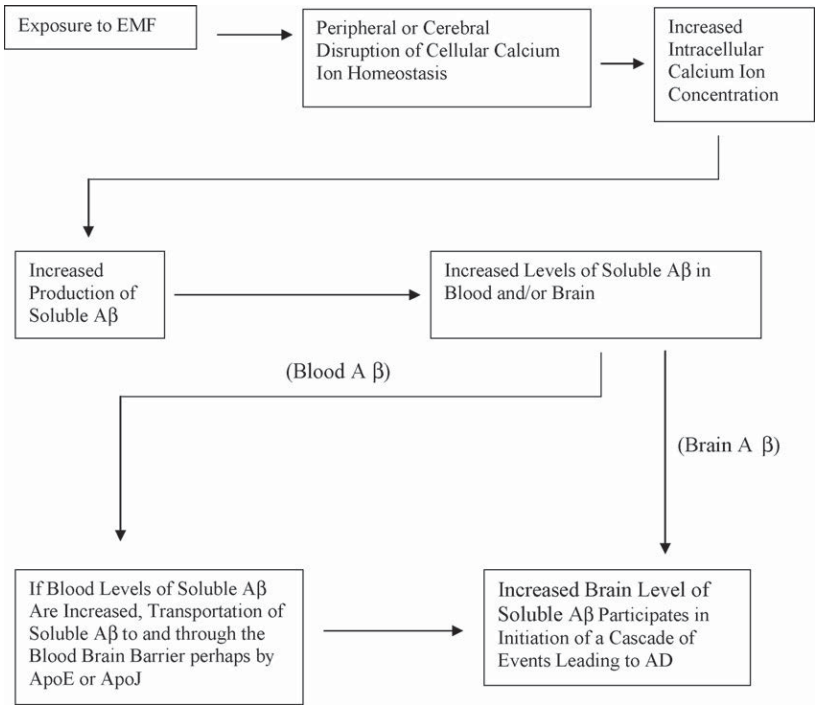

Fig. 1. Hypothesized biological pathway from MF exposure to AD Development (from Sobel and Davanipour [5]).

3.1. ELF MF exposure and peripheral and brain production of amyloid beta (Fig. 1)

The ELF MF exposure and increased amyloid beta hypothesis was developed by Sobel and Davanipour as a result of our initial findings that long-term ELF MF occupational exposure was a risk factor for AD [5] (see Fig. 1). Seamstress was the most common occupation among subjects with AD in the five databases we investigated [6–8]. ELF MF exposure among seamstresses had not been measured prior to our 1995 study [6]. Beginning in 1994, we measured a very large number of seamstresses working in either a factory setting or individually. Their exposures were very high, particularly when using an industrial sewing machine. The highest exposures were, however, not to the brain, because the motor on industrial machines is located at the knees. The motor or AC/DC transformer in home sewing machines is in the machine arm located near the operator's chest and right arm. This peripheral exposure led us to consider how peripheral ELF MF exposure might be associated with development of amyloid plaques in the brain.

Our biologically plausible hypothesis relating MF exposure to AD is based on the independent work of many researchers in several different fields. Details and references are provided in Sobel and Davanipour [5]. Briefly, the hypothesized process involves increased peripheral or brain production of Aβ as a result of MF exposure causing voltage-gated calcium ion channels to be open longer than normal. This results in abnormally high intracellular levels of calcium ions which in turn results in the production of Aβ. The resulting Aβ is quickly secreted into the blood. If peripheral, the Aβ is then transported to and through the blood–brain barrier, perhaps best chaperoned by the ε4 isoform of apolipoprotein E (apoE). (Note that this might be one reason why the ε4 isoform is a risk factor for AD.) Fig. 1 provides a schematic outline of the hypothesis. Each step in the proposed pathway is supported by *in vitro* studies.

At the time of publication of this hypothesis, no human studies related to this hypothesis had been conducted. There are now two groups that have published relevant studies, without apparently any knowledge of our hypothesis—or at least no reference to the hypothesis: (1) high levels of peripheral $A\beta_{1-42}$, the more neurotoxic version of Aβ, has been found to be a risk factor for AD [9,10]; acute exposure to ELF MF increases peripheral Aβ [11]. Details may also be found in the Bioinitiative Report (Section IIIA) [1].

3.2. Melatonin—background

Melatonin is found in every cell of the body and readily crosses the blood–brain barrier. It scavenges reactive oxygen species (ROS) at both physiologic and pharmacologic concentrations. In the literature, "physiologic" refers to blood level concentrations of melatonin, while "pharmacologic" indicates 2–3 orders of magnitude higher concentration. Recently, intracellular levels of melatonin, especially within the nucleus, have been shown to be naturally at "pharmacologic" levels for all cellular organelles studied to date [12,13].

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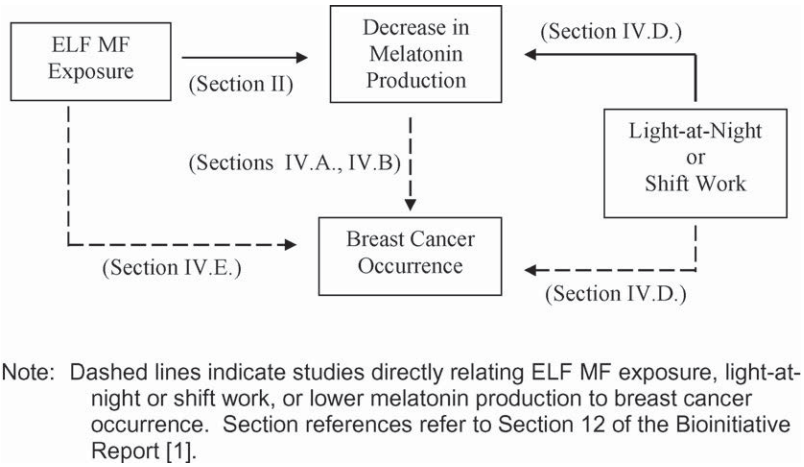

Fig. 2. Outline of the evidence that ELF MF exposure causes breast cancer through decreases in melatonin production—with section references to Section 12, Bioinitiative Report [1]. Note: Dashed lines indicate studies directly relating ELF MF exposure, light-at-night or shift work, or lower melatonin production to breast cancer occurrence.

3.3. Low melatonin production and Alzheimer's disease

Numerous *in vitro* and animal studies indicate that melatonin may be *protective* against AD and thus low or lowered melatonin production may be a risk factor for AD. These studies have found that melatonin has the following effects:

- Inhibition of the neurotoxicity and cytotoxicity of Aβ, including in mitochondria [14–19];
- Inhibition of the formation of β-pleated sheet structures and Aβ fibrils [20–25];
- Reversal of the profibrillogenic activity of apolipoprotein E ε4, an isoform conferring increased risk of AD [21];
- Inhibition of the oxidative stress *in vitro* and in transgenic mouse models of AD, if given early [23,26,27], but not necessarily if given to old mice [28];
- Increase in survival time in mouse models of AD [23];
- Reduction of oxidative stress and of proinflammatory cytokines induced by $A\beta_{1–40}$ in rat brain *in vitro* and *in vivo* [29–31];
- Decrease of the prevalence of $A\beta_{1–40}$ and $A\beta_{1–42}$ in the brain in young and middle aged mice [32];
- Improvement of memory and learning in rat models of AD pathology [33,34], but not necessarily in Aβ-infused rat models [35].

Note that transgenic mouse models of AD mimic senile plaque accumulation, neuronal loss, and memory impairment. There have been several reviews, e.g., [36–39]. Thus, chronic low levels of melatonin production may be etiologically related to AD incidence [40].

3.4. Low melatonin production and breast cancer

See Fig. 2 for a diagram of the discussed relationships between ELF MF exposure and breast cancer risk.

In vitro studies related to prevention of oxidative damage. Well over 1000 publications have found that melatonin neutralizes hydroxyl radicals and reduces oxidative damage. For reviews see Tan et al. [41] and Peyrot and Ducrocq [42]. Melatonin has also been shown to act synergistically with vitamin C, vitamin E and glutathione [43] and stimulates the antioxidant enzymes superoxide dismutase, glutathione peroxidase and glutathione reductase [44]. Furthermore,

- melatonin neutralizes hydroxyl radicals more efficiently than does reduced glutathione [45,46];
- melatonin reduces oxidative damage to macromolecules in the presence of free radicals [47,48] due at least to its free radical scavenging properties [49];
- melatonin increases the effectiveness of other antioxidants, e.g., superoxide dismutase, glutathione peroxidase, and catalase [50–54];
- melatonin has protective effects against ultraviolet and ionizing radiation [55–57];
- melatonin has been found to be a more potent protector from oxidative injury than vitamin C or vitamin E (micromoles/kg) (for a review of the evidence, see: Tan et al. [43];
- melatonin was also found *in vitro* to scavenge peroxyl radicals more effectively than vitamin E, vitamin C or reduced glutathione [58], although melatonin is not a very strong scavenger of peroxyl radicals [49].

Animal studies of melatonin and mammary tumor prevention. Several studies have found that melatonin inhibits the incidence of mammary tumors in laboratory animals either prone to such tumors or exposed to a carcinogen (e.g., [50–63]). Tan et al. [64,65] found that melatonin at both physiological and pharmacological levels protected Sprague–Dawley rats from safrole induced liver DNA adduct formation. Melatonin and retinoic acid appear to act synergistically in the chemoprevention of animal model tumors [66] and *in vitro* systems [67].

Melatonin prevents oxidative DNA damage by estradiol and radiation. Karbownik et al. [68] found that melatonin

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protects against DNA damage in the liver and kidney of male hamsters caused by estradiol treatment. Several studies have found that laboratory animals are protected by melatonin from lethal doses of ionizing radiation (e.g., [69–71]). Vijayalaxmi et al. [70] and Karbownik et al. [71] also investigated markers of oxidative DNA damage and found significant decreases in these markers in the melatonin treated animals.

Melatonin: Scavenger of •OH and Other ROS. Melatonin is a powerful, endogenously produced scavenger of reactive oxygen species (ROS), particularly the hydroxyl radical (•OH). Other ROS which melatonin scavenges include hydrogen peroxide (H_2O_2), nitric oxide ($NO^{\bullet}$), peroxynitrite anion ($ONOO^-$), hypochlorous acid (HOCl), and singlet oxygen ($^1O_2$) [50,72–75]. •OH is produced at high levels by natural aerobic activity. ROS are also produced by various biological activities or result from certain environmental and lifestyle (e.g., smoking) exposures. •OH is the most reactive and cytotoxic of the ROS [76]. •OH appears not to be removed by antioxidative enzymes, but is only detoxified by certain direct radical scavengers such as melatonin [77].

4. Discussion and future research

Other papers in this special issue of Pathophysiology provide evidence that RF MF exposure and ELF MF exposure may have similar biological consequences.

We primarily limit our discussion of future research to studies in humans with experimental medicine components, emphasizing the latter. However, we initially discuss limiting exposures.

It should be noted that ELF MF exposure may also be associated with other cancers. This may be because of the decrease in melatonin production and melatonin's varying antioxidant, anti-inflammation, and immune response enhancement properties.

4.1. Epidemiologic studies

The incidence rates of Alzheimer's disease and breast cancer are increasing. These increases are certainly in part due to our living longer, at least for AD, if not better lives. However, environmental exposures are likely to play important roles. At the same time, ELF and RF MF exposure is becoming more and more common in our world. In our three published studies of MF and AD, approximately 7.4–12.0% of the cases and 3.4–5.3% of the controls had primary occupations associated with medium or high ELF MF exposure [6–8]. Many more subjects may have had exposures from sources generally not identified in epidemiologic studies, because individualized 'on-site' exposure assessment is usually not feasible. We give two examples coming from 'onsite' inspections we have performed: a subject who had developed amyotrophic lateral sclerosis (ALS) had spent many years with a 75 mG ELF MF exposure due to having his foot on a deadbolt lock/unlock foot devise for his office door under his desk; a subject who had developed AD who spent over 25 years sitting at his home desk for at least 4 h per day in a chair backed up to a wall with a fuse box directly on the other side of the wall which produced a very high ELF MF exposure to his back and head. (Note that there is also significant epidemiologic evidence that ELF MF exposure is a risk factor for ALS.) The frequencies of such exposures in studies are unknown.

As is often the case, more research is required. However, the designs of this future research should be informed and directed by the results of previous research. Future epidemiologic studies should use subjects for whom it is unequivocally known that the ELF MF and/or RF MF exposure is high and matched subjects for whom such exposure is known to be low. Matching criteria should include age, gender, and residential environment so as to at least partially exclude other exposures.

There should be additional studies related to the levels of production of peripheral amyloid beta, particularly $A\beta_{1–42}$, and melatonin, on the one hand, and both MF exposure and the risk of AD, on the other hand. Such studies need to be able to investigate the possible associations between peripheral amyloid beta and melatonin levels and both earlier/concurrent MF exposure and subsequent development of AD. Similar studies need to be carried out for breast cancer, excluding the amyloid beta component. This effort will likely require both retrospective and longitudinal studies. There are only two known longitudinal studies [3,4] which collected urine samples at baseline so that overnight premorbid melatonin production was reliably estimated. These studies found an association between low melatonin production and breast cancer. These studies may also be able to provide important additional information if it is possible to determine MF exposures with reasonable accuracy and follow-up AD status on a sufficient number of participants.

Case-control studies of melatonin as a risk factor for AD and breast cancer are hampered by the fact that biological sequelae of both AD and breast cancer result in a decline of melatonin production to an unknown extent. (In breast cancer patients, there is a melatonin production rebound when tumors are surgically removed. In AD patients, the production of serotonin, the precursor of melatonin, is decreased and noradrenergic regulation becomes dysfunctional [78].) However, melatonin production is partially under genetic control. We have conducted a study of relatively healthy members of nuclear families and melatonin production (DOD Congressionally Directed Medical Research Program Grant: DAMD17-00-1-0692). The production of melatonin of the mother was successfully modelled as a function of the melatonin of a daughter, after adjusting for both the daughter's age and the influence of the father. This work allows for the design of case-control studies of the influence of long-term MF exposure on both melatonin production and the risks of breast cancer and AD.

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4.2. ELF and/or RF MF exposure mitigation

It is also vital to mitigate both the extent of MF exposure and the effects of such exposure. Mitigation means efforts to both locate and shield or move the sources of MF away from individuals and design equipment which produces lower levels of MF. Little effort has apparently been spent on design issues. There are simple things that can be done. For example, almost all AC/DC transformers emit about 75 mG ELF MF fields. The exception, in our experience, has been a few transformers for Apple laptops measured about 10 years ago. AC/DC transformers are now everywhere, specifically under and around office desks and in nearly every room in a residence, often near the heads of beds. Maximizing one's distance from a transformer is important, because the strength of the MF field drops off with the square or cube of the distance from the source.

Seamstress is a very common profession and being a seamstress is clearly a risk factor for AD and quite possibly for breast cancer also. Seamstresses experience higher ELF MF exposure than members of almost any other profession. Older industrial sewing machines are extremely common all over the world. They produce extremely strong MFs, but it is possible to design "covers" for the motor to interfere with these fields, much as "headphones" can mitigate sound waves. Newer computer driven home sewing machines produce MF because of the AC/DC transformer. These transformers are placed in the arm of the machine, which results in high MF exposure to the operator. Simply by connecting the transformer to the machine by an electrical cord about three or more feet from the operator would mitigate a significant percentage of the MF exposure.

4.3. Biological mechanisms/experimental medicine research

We argue that, to the extent possible, research should now be conducted in humans. We list the following research questions as important examples of studying the biological effects of ELF and/or RF MF exposure:

1. Generation of peripheral amyloid beta
   a. Determination of intracellular Ca^{2+} ion concentration changes as a consequence of ELF or RF MF exposure.
   b. Measurement of the amount of $A\beta_{1–42}$ and $A\beta_{1–40}$ produced by and secreted from cells.
      i. This could be done at least by measuring blood levels of amyloid before and after ELF and/or RF MF exposure.
      ii. Perhaps there are more sophisticated experimental designs.
   c. Determination of which cell types in fact produce more amyloid beta after or during ELF and/or RF MF exposure.
   d. Determination of the dose response relationship(s) between ELF and/or RF MF exposure and cellular amyloid beta production.
   e. Measurement of the accumulation of amyloid beta in the brain, perhaps using PET scans [79,80].
2. Decrease in melatonin production

   Note: it is known that the pineal gland, the primary source of melatonin, has a tendency to become calcified and, perhaps, this is the reason why generally there is a reduction of melatonin production during aging.
   a. Determination of the extent of intracellular calcium within the pineal gland as a result of acute ELF and/or RF MF exposure.
   b. Determination of the extent of calcification of the pineal gland as a result of varying levels of long-term ELF and/or RF MF exposure.

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References

[1] Z. Davanipour, E. Sobel, Section 12: Magnetic Field Exposure: Melatonin Production; Alzheimer's Disease; Breast Cancer, in: C.F. Blackman, M. Blank, M. Kundi, C. Sage (Organizing Committee), BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF), 2007. URL: http://www.bioinitiative.org/report/docs/section_12.pdf.

[2] BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF), 2007. URL: http://www.bioinitiative.org/report/index.htm.

[3] E.S. Schernhammer, S.E. Hankinson, Urinary melatonin levels and breast cancer risk, J. Natl. Cancer Inst. 97 (2005) 1084–1087.

[4] E.S. Schernhammer, F. Berrino, V. Krogh, G. Secreto, A. Micheli, E. Venturelli, S. Sieri, C.T. Sempos, A. Cavalleri, H.J. Schünemann, S. Strano, P. Muti, Urinary 6-sulfatoxymelatonin levels and risk of breast cancer in postmenopausal women, J. Natl. Cancer Inst. 100 (2008) 898–905.

[5] E. Sobel, Z. Davanipour, Electromagnetic field exposure may cause increased production of amyloid beta and eventually lead to Alzheimer's disease, Neurology 47 (1996) 1594–1600.

[6] E. Sobel, Z. Davanipour, R. Sulkava, T. Erkinjuntti, J. Wikstrom, V.W. Henderson, G. Buckwalter, J.D. Bowman, P.J. Lee, Occupations with exposure to electromagnetic fields: a possible risk factor for Alzheimer's disease, Am. J. Epidemiol. 142 (1995) 515–524.

[7] E. Sobel, M. Dunn, Z. Davanipour, Z. Qian, H.C. Chui, Elevated risk of Alzheimer's disease among workers with likely electromagnetic field exposure, Neurology 47 (1996) 1477–1481.

[8] Z. Davanipour, C.-C. Tseng, P.-J. Lee, E. Sobel, A case-control study of occupational magnetic field exposure and Alzheimer's disease: results from the California Alzheimer's Disease Diagnosis and Treatment Centers, BMC Neurol. 7 (2007) 13, http://www.biomedcentral.com/1471-2377/7/13.

[9] R. Mayeux, W.X. Tang, D.M. Jacobs, J. Manly, K. Bell, C. Merchant, S.A. Small, Y. Stern, H.M. Wisniewski, P.D. Mehta, Plasma amyloid beta-peptide 1–42 and incipient Alzheimer's disease, Ann. Neurol. 46 (1999) 412–416.

[10] R. Mayeux, L.S. Honig, M.X. Tang, J. Manly, Y. Stern, N. Schupf, P.D. Mehta, Plasma A[beta]40 and A[beta]42 and Alzheimer's disease: relation to age, mortality, and risk, Neurology 61 (2003) 1185–1190.

Please cite this article in press as: Z. Davanipour, E. Sobel, Long-term exposure to magnetic fields and the risks of Alzheimer's disease and breast cancer: Further biological research, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.01.005

[11] C. Noonan, J. Reif, J. Burch, T.Y. Ichinose, M.G. Yost, K. K. Magnusson, Relationship between amyloid β protein and melatonin metabolite in a study of electric utility workers, J. Occup. Environ. Med. 44 (2002) 769–775.
[12] G.J.M. Maestroni, Therapeutic potential of melatonin in immunodeficiency states, viral diseases, and cancer, in: G. Heuther, W. Kochen, T.J. Simat, H. Steinhart (Eds.), Tryptophan, Serotonin, and Melatonin: Basic Aspects and Applications, Kluwer Academic/Plenum Publishers, New York, 1999, pp. 217–226.
[13] R.J. Reiter, D.-X. Tan, W. Qi, L.C. Manchester, M. Karbownik, J.R. Calvo, Pharmacology and physiology of melatonin in the reduction of oxidative stress in vivo, Biol. Signals Recept. 9 (2000) 160–171.
[14] M.A. Pappolla, M. Sos, R.A. Omar, R.J. Bick, D.L. Hickson-Bick, R.J. Reiter, S. Efthimiopoulos, N.K. Robakis, Melatonin prevents death of neuroblastoma cells exposed to the Alzheimer amyloid peptide, J. Neurosci. 17 (1997) 1683–1690.
[15] M.A. Pappolla, Y.J. Chyan, B. Poeggeler, P. Bozner, J. Ghiso, S.P. LeDoux, G.L. Wilson, Alzheimer beta protein mediated oxidative damage of mitochondrial DNA: prevention by melatonin, J. Pineal Res. 27 (1999) 226–229.
[16] M.A. Pappolla, M.J. Simovich, T. Bryant-Thomas, Y.J. Chyan, B. Poeggeler, M. Dubocovich, R. Bick, G. Perry, F. Cruz-Sanchez, M.A. Smith, The neuroprotective activities of melatonin against the Alzheimer beta-protein are not mediated by melatonin membrane receptors, J. Pineal Res. 32 (2002) 135–142.
[17] Y.X. Shen, W. Wei, S.Y. Xu, Protective effects of melatonin on cortico-hippocampal neurotoxicity induced by amyloid beta-peptide 25–35, Acta Pharmacol. Sin. 23 (2002) 71–76.
[18] P. Zatta, G. Tognon, P. Carampin, Melatonin prevents free radical formation due to the interaction between beta-amyloid peptides and metal ions [Al(III), Zn(II), Cu(II), Mn(II), Fe(II)], J. Pineal Res. 35 (2003) 98–103.
[19] M.H. Jang, S.B. Jung, M.H. Lee, C.J. Kim, Y.T. Oh, I. Kang, J. Kim, E.H. Kim, Melatonin attenuates amyloid beta25–35-induced apoptosis in mouse microglial BV2 cells, Neurosci. Lett. 380 (2005) 26–31.
[20] M. Pappolla, P. Bozner, C. Soto, H. Shao, N.K. Robakis, M. Zagorski, B. Frangione, J. Ghiso, Inhibition of Alzheimer beta-fibrillogenesis by melatonin, J. Biol. Chem. 273 (1998) 7185–7188.
[21] B. Poeggeler, L. Miravalle, M.G. Zagorski, T. Wisniewski, Y.J. Chyan, Y. Zhang, H. Shao, T. Bryant-Thomas, R. Vidal, B. Frangione, J. Ghiso, M.A. Pappolla, Melatonin reverses the profibrillogenic activity of apolipoprotein E4 on the Alzheimer amyloid Aβ peptide, Biochemistry 40 (2001) 14995–15001.
[22] Z. Skribanek, L. Balaspiri, M. Mak, Interaction between synthetic amyloid-beta-peptide (1–40) and its aggregation inhibitors studied by electrospray ionization mass spectrometry, J. Mass Spectrom. 36 (2001) 1226–1229.
[23] E. Matsubara, T. Bryant-Thomas, J. Pacheco Quinto, T.L. Henry, B. Poeggeler, D. Herbert, F. Cruz-Sanchez, Y.J. Chyan, M.A. Smith, G. Perry, M. Shoji, K. Abe, A. Leone, I. Grundke-Ikbal, G.L. Wilson, J. Ghiso, C. Williams, L.M. Refolo, M.A. Pappolla, D.G. Chain, E. Neria, Melatonin increases survival and inhibits oxidative and amyloid pathology in a transgenic model of Alzheimer's disease, J. Neurochem. 85 (2003) 1101–1108 (Erratum in: J. Neurochem. 86 (2003) 1312).
[24] Z. Feng, Y. Chang, Y. Cheng, B.L. Zhang, Z.W. Qu, C. Qin, J.T. Zhang, Melatonin alleviates behavioral deficits associated with apoptosis and cholinergic system dysfunction in the APP 695 transgenic mouse model of Alzheimer's disease, J. Pineal Res. 37 (2004) 129–136.
[25] X. Cheng, R.B. van Breemen, Mass spectrometry-based screening for inhibitors of β-amyloid protein aggregation, Anal. Chem. 77 (2005) 7012–7015.
[26] K.L. Clapp-Lilly, M.A. Smith, G. Perry, P.L. Harris, X. Zhu, L.K. Duffy, Melatonin acts as antioxidant and pro-oxidant in an organotypic slice culture model of Alzheimer's disease, Neuroreport 12 (2001) 1277–1280.
[27] Z. Feng, C. Qin, Y. Chang, J.T. Zhang, Early melatonin supplementation alleviates oxidative stress in a transgenic mouse model of Alzheimer's disease, Free Radic. Biol. Med. 40 (2006) 101–109.
[28] J. Quinn, D. Kulhanek, J. Nowlin, R. Jones, D. Pratico, J. Rokach, R. Stackman, Chronic melatonin therapy fails to alter amyloid burden or oxidative damage in old Tg2576 mice: implications for clinical trials, Brain Res. 1037 (2005) 209–213.
[29] K.L. Clapp-Lilly, M.A. Smith, G. Perry, L.K. Duffy, Melatonin reduces interleukin secretion in amyloid-beta stressed mouse brain slices, Chem. Biol. Interact. 134 (2001) 101–107.
[30] Y.X. Shen, S.Y. Xu, W. Wei, X.X. Sun, L.H. Liu, J. Yang, C. Dong, The protective effects of melatonin from oxidative damage induced by amyloid beta-peptide 25–35 in middle-aged rats, J. Pineal Res. 32 (2002) 85–89.
[31] S. Rosales-Corral, D.-X. Tan, R.J. Reiter, M. Valdivia-Velazquez, G. Martinez-Barboza, J.P. Acosta-Martinez, G.G. Ortiz, Orally administered melatonin reduces oxidative stress and proinflammatory cytokines induced by amyloid-beta peptide in rat brain: a comparative, in vivo study versus vitamin C and E, J. Pineal Res. 35 (2003) 80–84.
[32] D.K. Lahiri, D. Chen, Y.W. Ge, S.C. Bondy, E.H. Sharman, Dietary supplementation with melatonin reduces levels of amyloid beta-peptides in the murine cerebral cortex, J. Pineal Res. 36 (2004) 224–231.
[33] Y.X. Shen, W/Wei, J. Yang, C. Liu, C. Dong, S.Y. Xu, Improvement of melatonin to the learning and memory impairment induced by amyloid beta-peptide 25–35 in elder rats, Acta Pharmacol. Sin. 22 (2001) 797–803.
[34] M. Weinstock, S. Shoham, Rat models of dementia based on reductions in regional glucose metabolism, cerebral blood flow and cytochrome oxidase activity, J. Neural Transm. 111 (2004) 347–366.
[35] F. Tang, S. Nag, S.Y. Shiu, S.F. Pang, The effects of melatonin and Ginkgo biloba extract on memory loss and choline acetyltransferase activities in the brain of rats infused intracerebroventricularly with beta-amyloid 1–40, Life Sci. 71 (2002) 2625–2631.
[36] D.P. Cardinali, A.M. Furio, M.P. Reyes, Clinical perspectives for the use of melatonin as a chronobiotic and cytoprotective agent, Ann. NY Acad. Sci. 1057 (2005) 327–336.
[37] V. Srinivasan, S. Pandi-Perumal, D. Cardinali, B. Poeggeler, R. Hardeland, Melatonin in Alzheimer's disease and other neurodegenerative disorders, Behav. Brain Funct. 2 (2006) 15, doi:10.1186/1744-9081-2-15.
[38] Y. Cheng, Z. Feng, Q.Z. Zhang, J.T. Zhang, Beneficial effects of melatonin in experimental models of Alzheimer disease, Acta Pharmacol. Sin. 27 (2006) 129–139.
[39] J.Z. Wang, Z.F. Wang, Role of melatonin in Alzheimer-like neurodegeneration, Acta Pharmacol. Sin. 27 (2006) 41–49.
[40] Y.H. Wu, D.F. Swaab, The human pineal gland and melatonin in aging and Alzheimer's disease, J. Pineal Res. 38 (2005) 145–152.
[41] D.-X. Tan, L.C. Manchester, M.P. Terron, L.J. Flores, R.J. Reiter, One molecule, many derivatives: a never-ending interaction of melatonin with reactive oxygen and nitrogen species? J. Pineal Res. 42 (2007) 28–42.
[42] F. Peyrot, C. Ducrocq, Potential role of tryptophan derivatives in stress responses characterized by the generation of reactive oxygen and nitrogen species, J. Pineal Res. 45 (2008) 235–246.
[43] D.-X. Tan, L.C. Manchester, R.J. Reiter, W.B. Qi, M. Karbownik, J.R. Calvo, Significance of melatonin in antioxidative defense system: reactions and products, Biol. Signals Recept. 9 (2000) 137–159.
[44] R.J. Reiter, D.-X. Tan, S. Burkhardt, Reactive oxygen and nitrogen species and cellular and organismal decline: amelioration with melatonin, Mech. Ageing Dev. 123 (2002) 1007–1019.
[45] D.-X. Tan, L.D. Chen, B. Poeggeler, L.C. Manchester, R.J. Reiter, Melatonin: a potent, endogenous hydroxyl radical scavenger, Endocr. J. 1 (1993) 57–60.
[46] H.J. Bromme, W. Morke, D. Peschke, H. Ebelt, D. Peschke, Scavenging effect of melatonin on hydroxyl radicals generated by alloxan, J. Pineal Res. 29 (2000) 201–208.

Please cite this article in press as: Z. Davanipour, E. Sobel, Long-term exposure to magnetic fields and the risks of Alzheimer's disease and breast cancer: Further biological research, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.01.005

[47] R.J. Reiter, L. Tang, J.J. Garcia, A. Munoz-Hoyos, Pharmacological actions of melatonin in oxygen radical pathophysiology, Life Sci. 60 (1997) 2255–2271.
[48] R.J. Reiter, D.-X. Tan, L.C. Manchester, W. Qi, Biochemical reactivity of melatonin with reactive oxygen and nitrogen species: a review of the evidence, Cell Biochem. Biophys. 34 (2001) 237–256.
[49] R.J. Reiter, D. Acuna-Castroviejo, D.-X. Tan, S. Burkhardt, Free radical-mediated molecular damage: mechanisms for the protective actions of melatonin in the central nervous system, Ann. NY Acad. Sci. 939 (2001) 200–215.
[50] I. Antolin, B. Obst, S. Burkhardt, R. Hardeland, Antioxidative protection in a high-melatonin organism: The dinoflagellate *Gonyaulax polydera* is rescued from lethal oxidative stress by strongly elevated, but physiologically possible, concentrations of melatonin, J. Pineal Res. 23 (1997) 182–190.
[51] M. Kotler, C. Rodriguez, R.M. Sainz, I. Antolin, A. Menendez-Pelaez, Melatonin increases gene expression for antioxidant enzymes in rat brain cortex, J. Pineal Res. 24 (1998) 83–89.
[52] M.I. Pablos, J.I. Chuang, J.R. Reiter, G.G. Ortiz, W.M. Daniels, E. Sewerynek, D. Melchiorri, B. Poeggeler, Time course of melatonin-induced increase in glutathione peroxidase activity in chick tissues, Biol. Signals 4 (1995) 325–330.
[53] L.R. Barlow-Walden, R.J. Reiter, A. Abe, M. Pablos, A. Menendez-Pelaez, L.D. Chen, B. Poeggeler, Melatonin stimulated brain glutathione peroxidase activity, Neurochem. Int. 26 (1995) 497–502.
[54] P. Montilla, I. Tunez, M.C. Munoz, J.V. Soria, A. Lopez, Antioxidative effect of melatonin in rat brain oxidative stress induced by Adriamycin, Rev. Esp. Fisiol. 53 (1997) 301–305.
[55] Vijayalaxmi, R.J. Reiter, M.L. Meltz, Melatonin protects human blood lymphocytes from radiation-induced chromosome damage, Mutat. Res. 346 (1995) 23–31.
[56] Vijayalaxmi, R.J. Reiter, T.S. Herman, M.L. Meltz, Melatonin and radioprotection from genetic damage: DNA damage in human blood lymphocytes, Mutat. Res. 371 (1996) 221–228.
[57] Vijayalaxmi, R.J. Reiter, M.L. Meltz, T.S. Herman, Melatonin: possible mechanisms involved in its "radioprotective" effect, Mutat. Res. 404 (1998) 187–189.
[58] C. Pieri, M. Marra, F. Moroni, R. Recchioni, F. Marcheselli, Melatonin: a peroxyl radical scavenger more effective than vitamin E, Life Sci. 55 (1994) 271–276.
[59] L. Tamarkin, M. Cohen, D. Roselle, C. Reichert, M. Lippman, B. Chabner, Melatonin inhibition and pinealectomy enhancement of 7,12-dimethylbenz(a)anthracene-induced mammary tumors in the rat, Cancer Res. 41 (1981) 4432–4436.
[60] P.N. Shah, M.C. Mhatre, L.S. Kothari, Effect of melatonin on mammary carcinogenesis in intact and pinealectomized rates in varying photoperiods, Cancer Res. 44 (1984) 3403–3407.
[61] L.S. Kothari, P.N. Shah, M.C. Mhatre, Pineal ablation in varying photoperiods and the incidence of 9,10-dimethyl-1,2-benzathracene induced mammary cancer in rats, Cancer Lett. 22 (1984) 99–102.
[62] A. Subramanian, L. Kothari, Suppressive effect by melatonin on different phases of 9,10-dimethyl-1,2-benzanthracene (DMBA)-induced rat mammary gland carcinogenesis, Anticancer Drugs 2 (1991) 297–303.
[63] A. Subramanian, L. Kothari, Melatonin, a suppressor of spontaneous murine mammary tumors, J. Pineal Res. 10 (1991) 136–140.
[64] D.-X. Tan, B. Poeggeler, R.J. Reiter, L.D. Chen, S. Chen, L.C. Manchester, L.R. Barlow-Walden, The pineal hormone melatonin inhibits DNA-adduct formation induced by the chemical carcinogen safrole in vivo, Cancer Lett. 70 (1993) 65–71.
[65] D.-X. Tan, R.J. Reiter, L.D. Chen, B. Poeggeler, L.C. Manchester, L.R. Barlow-Walden, Both physiological and pharmacological levels of melatonin reduce DNA adduct formation induced by the carcinogen safrole, Carcinogenesis 15 (1994) 215–218.
[66] S.R. Teplitzky, T.L. Kiefer, Q. Cheng, P.D. Dwivedi, K. Moroz, L. Myers, M.B. Anderson, A. Collins, J. Dai, L. Yuan, L.L. Spriggs, D.E. Blask, S.M. Hill, Chemoprevention of NMU-induced rat mammary carcinoma with the combination of melatonin and 9-cis-retinoic acid, Cancer Lett. 26 (2001) 155–163.
[67] K. Eck-Enriquez, T.L. Kiefer, L.L. Spriggs, S.M. Hill, Pathways through which a regimen of melatonin and retinoic acid induces apoptosis in MCF-7 human breast cancer cells, Breast Cancer Res. Treat. 61 (2000) 229–239.
[68] M. Karbownik, R.J. Reiter, J. Cabrera, J.J. Garcia, Comparison of the protective effect of melatonin with other antioxidants in the hamster kidney model of estradiol-induced DNA damage, Mutat. Res. 474 (2001) 87–92.
[69] R.T. Blickenstaff, S.M. Brandstadter, S. Reddy, R. Witt, Potential radioprotective agents. 1. Homologues of melatonin, J. Pharm. Sci. 83 (1994) 216–218.
[70] Vijayalaxmi, M.L. Meltz, R.J. Reiter, T.S. Herman, K.S. Kumar, Melatonin and protection from whole-body irradiation: survival studies in mice, Mutat Res. 425 (1999) 21–27.
[71] M. Karbownik, R.J. Reiter, W. Qi, J.J. Garcia, D.X. Tan, L.C. Manchester, Vijayalaxmi, Protective effects of melatonin against oxidation of guanine bases in DNA and decreased microsomal membrane fluidity in rat liver induced by whole body ionizing radiation, Mol. Cell. Biochem. 211 (2000) 137–144.
[72] R.J. Reiter, Pineal melatonin: cell biology of its synthesis and of its physiological interactions, Endocr. Rev. 12 (1991) 151–158.
[73] D.-X. Tan, L.C. Manchester, R.J. Reiter, W.B. Qi, M. Karbownik, J.R. Calvo, Significance of melatonin in antioxidant defense system: reactions and products, Biol. Signals Recept. 9 (2000) 137–159.
[74] R. Hardeland, I. Blazer, B. Poeggeler, B. Fuhrberg, H. Uria, G. Behrmann, R. Wolf, T.J. Meyer, R.J. Reiter, On the primary functions of melatonin in evolution: Mediation of photoperiodic signals in a unicell, photooxidation and scavenging of free radicals, J. Pineal Res. 18 (1995) 104–111.
[75] P. Stasica, P. Ulanski, J.M. Rosiak, Melatonin as a hydroxyl radical scavenger, J. Radioanal. Nucl. Chem. 232 (1998) 107–113.
[76] B. Halliwell, J.M. Gutteridge, Oxygen free radicals and iron in relation to biology and medicine: some problems and concepts, Arch. Biochem. Biophys. 246 (1986) 501–514.
[77] D.-X. Tan, L.C. Manchester, R.J. Reiter, B.F. Plummer, Cyclic 3-hydroxymelatonin: a melatonin metabolite generated as a result of hydroxyl radical scavenging, Biol. Signals Recept. 8 (1999) 70–74.
[78] Y.H. Wu, W.G. Feenstra, J.N. Zhou, R.Y. Liu, J.S. Toranõ, H.J. Van Kan, D.F. Fischer, R. Ravid, D.F. Swaab, Molecular changes underlying reduced pineal melatonin levels in Alzheimer disease: alterations in preclinical and clinical stages, J. Clin. Endocrinol. Metab. 88 (2003) 5898–5906.
[79] W.E. Klunk, H. Engler, A. Nordberg, Y. Wang, G. Blomqvist, D.P. Holt, M. Bergstrom, I. Savitcheva, G.F. Huang, S. Estrada, B. Ausen, M.L. Debnath, J. Barletta, J.C. Price, J. Sandell, B.J. Lopresti, A. Wall, P. Koivisto, G. Antoni, C.A. Mathis, B. Langstrom, Imaging brain amyloid in Alzheimer's disease with Pittsburgh Compound-B, Ann. Neurol. 55 (2004) 306–319.
[80] G.W. Small, V. Kepe, L.M. Ercoli, P. Siddarth, S.Y. Bookheimer, K.J. Miller, H. Lavretsky, A.C. Burggren, G.M. Cole, H.V. Vinters, P.M. Thompson, S.C. Huang, N. Satyamurthy, M.E. Phelps, J.R. Barrio, PET of brain amyloid and tau in mild cognitive impairment, N. Engl. J. Med. 355 (2006) 2652–2663.

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Reproductive and developmental effects of EMF in vertebrate animal models

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Abstract

This paper reviews the literature data on the effects of electromagnetic fields (EMF), in the reproductive organs as well as in prenatal and postnatal development of vertebrate animals. Review articles which have been published till 2001, regarding the reproductive and developmental effects of the entire range of frequency of electromagnetic fields, were surveyed. Experimental studies which were published from 2001 onwards were summarized. Special focus on the effects of radiofrequencies related to mobile communication in the above mentioned topics has been made. According to the majority of the investigations, no strong effects resulted regarding the exposure to EMF of mobile telephony in the animal reproduction and development. However further research should be done in order to clarify many unknown aspects of the impact of EMF in the living organisms.

Keywords: Electromagnetic fields (EMF); Mobile phones; Teratology; Endometrium; Testis

1. Introduction

During the 20th century, the exposure to electromagnetic fields (EMF) became an important source of concern about the possible effects in the living organisms. The artificial sources of electromagnetic radiation have risen tremendously because of the ongoing needs on electricity, telecommunications, and electronic devices. In this context, World Health Organisation (WHO) established in 1996 the International EMF project in order to assess health and environmental effects of exposure to EMF in the frequency range from 0 to 300 GHz. For the purpose of this paper this range will be divided into static (0 Hz), extremely low frequency (ELF > 0–300 kHz), intermediate frequencies (IF > 300–10 MHz) and radiofrequency (RF 10 MHz–300 GHz) fields [J. Juutilainen, Developmental effects of electromagnetic fields, Bioelectromagnetics 7 (2005) S107–S115]. The mobile phone technology is based on radiofrequency radiation with transmission of microwaves carrying frequencies between 880 and 1800 MHz [P.A. Valberg, T.E. van Deventer, M.H. Repacholi, Workgroup report: base stations and wireless networks-radiofrequency (RF) exposures and health consequences, Environ. Health Perspect. 115 (2007) 416–424].

The mobile telephony revolution took place in the last decade. There is an increasing number of cell phone users all over the world. Also, new technologies which use the spectrum of high frequency emissions are incorporated in many aspects of telecommunications. As a consequence, there is a lot of interest about the possible effects of the radiation emitted from the machines which are engaged in the telephony such as hand phones, base stations and transmitters.

The biological effects of EMF have been and are being investigated on different levels of organization. On the level of human populations, epidemiological studies are used whereas, on the level of individuals human, animal and plant *in vivo* experiments are carried out. Furthermore, on the level of organs, tissues and cells *in vitro* investigations are employed. Finally, on the sub-cellular level, biochemical and molecular techniques are utilized.

From another point of view, many studies have been carried out or are in progress about the various effects of radiation emissions regarding the behaviour, cancer, central nervous system, sleep, children, cardiovascular system, immune function, reproduction and development [3].

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The present paper will focus on the existing data about the reproductive and developmental effects of EMF in vertebrates. Reproduction is a critical function of the organisms and involves two body systems the male and female genital system. The development comprises a series of events which begins with fertilization, continues with implantation, embryonic growth and terms with sexual maturity. In the context of systematic zoology, the vertebrates are close to the humans. Therefore, the animal studies could provide useful information on the comprehension of interaction of EMF with the living organism and on the possible commonality with the humans.

The biological effects of EMF of interest can be broadly grouped into thermal and non-thermal [4]. The thermal effects are associated with local heat production just like the mechanism of a microwave oven. The non-thermal mechanism is triggered by an amount of energy absorption, which is not directly associated with temperature change but rather to some other changes produced in the tissues.

The goal of this paper is to present the up to date available data about the EMF and their potential effects on reproduction and development, filling the gap of information from the most recent published reviews. All the bibliographic data which will be presented were collected exclusively from scientific journals published in English and partially in other languages. The survey includes studies which were published from 2001 onward. The studies which relate to the impact of mobile phone electromagnetic fields will be presented thoroughly and independently from the date of their publication.

2. Historical background

The first paper which I found in the medical literature, regarding the effects of EMF on the development of vertebrates, was published in 1893 in an anatomical journal from Windle [5]. The author summarized the observations of three scientists and added his own about the effects of electricity on the chicken embryos. Two years later the same author [6], published an account on the effects of electricity and magnetism on development.

In 1980 two papers were published about the biological effects of microwave radiation. Cook et al. [7] published a comprehensive survey regarding the very early research on the biological effects of electromagnetic fields. The early work on short waves from 1885 to 1940 was presented. Following, the authors summarized the available data from 1940 to 1960. Leach [8] provided an account on the genetic, growth and reproductive effects of microwave radiation including early studies in this field that were published from 1959 to 1979. The majority of revised papers dealt with animals. Later, Algers and Hennichs [9] summarized the biological effects on vertebrates, of electromagnetic fields where the frequency did not exceed 100 Hz. The authors included many studies about the impact of EMF on farm animals. The same year, a specialized review was published on the effects of non-ionizing radiation on birds [10].

Berman et al. [11], presented the results of a large multinational experimental effort (Henhouse project) regarding the low frequency EMF effects on chick embryos. Juutilainen [12], Chernoff et al. [13], Brent et al. [14] presented detailed reviews of the literature about the effects on reproduction related to low frequency EMF.

Jensh [15] reviewed behavioral teratologic studies using microwave radiation with special interest to continuous wave (CW) 915, 2450, or 6000 MHz radiation.

Verschaeve and Maes [16] reviewed the genetic, carcinogenic and teratogenic effects of RF (300 MHz–300 GHz). Regarding the effects on reproduction and teratogenesis, studies from 1961 to 1991 were surveyed. The majority of these experimental studies dealt with the exposure of animals at 2.45 GHz. The same year, Huuskonen et al. [17] reported on the teratogenic and reproductive effects of low frequency (0–100 kHz) magnetic fields associated with the use or transmission of electric power or emitted from video display terminals. The animal studies that were surveyed, have been published from 1987 to 1997 regarding the effects of alternating magnetic fields on prenatal development of rats and mice. In the same paper, studies on the effects of prenatal exposure of alternating magnetic fields on postnatal development were included. Brent [18] provided a thorough review of *in vivo* and *in vitro* studies on the reproductive and teratologic effects of low frequency EMF. The survey of reproductive effects has involved studies with chick embryos, chickens, cows, mice, and rats from 1969 to 1996. O'Connor [19] recorded the intrauterine effects in animals exposed to radiofrequency and microwave fields with a special feature. The SAR of the surveyed studies was above the limit of 0.4 W/kg.

Experimental studies on the teratologic effects or developmental abnormalities from exposure to RF electromagnetic fields in the range 3 kHz–300 GHz were reviewed from Heynick and Merritt [20]. The review included investigations with insects, birds (chicken, quails, turkeys) and mammalian species (mice, rats) as well as non-human primates which appeared from 1974 to 2000. A brief critical review on the developmental effects of extremely low frequency (ELF) electric and magnetic fields provided by Juutilainen [21]. Löscher [22] published a survey of the effects of radiofrequency electromagnetic fields on production, health and behaviour of farm animals.

Juutilainen [1] reported on the effects of EMF on animal development. In his review, he surveyed specific topics such as the Henhouse project, the interaction of LF-IMF EMF with known teratogens, and the behavioral teratology of RF. Saunders and McCaig [23] summarized the possible effects on prenatal development of physiologically weak electric fields induced in the body by exposure to extremely low frequency electromagnetic fields and of elevated temperature levels that might result from exposure to radiofrequency (RF) radiation.

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Table 1
Overview of investigations on EMF effects on animal genital system.

Animal species	Exposure frequency	Exposure parameters	Exposure duration	Endpoint	Results	Comments	Reference
Mouse Swiss	50 Hz	25 mT	Continuous 90 days	Effects on reproductive ability	No effect on the fertility of male and female mice. The ovarian weight was significantly increased		[27]
Mouse CD1 (BALB/c X DBA/2)	60 Hz	2 mT	Continuous for 72 h or 8 h/day for 10 days	Sperm morphology	No statistically differences were observed	Two groups were treated with mitomycin C. Sperm abnormalities were found in the group exposed versus the group treated with mitomycin C alone	[28]
Mouse BALB/c	60 Hz	0.1 or 0.5 mT	24 h/day for 8 weeks	Germ cell apoptosis in the testes	No significant changes in testicular weights. Decrease of normal seminiferous tubules. Increase of the germ cell death		[29]
Rat Sprague–Dawley	60 Hz	5, 83.3, 500 mT	Continuous 21 h/day from day 6 of gestation to day 21 of lactation	Spermatotoxicity and reproductive dysfunction inthe F1 offspring	No detectable alterations in offspring spermatogenesis and fertility		[30]
Rat Sprague–Dawley	50 Hz	25 ± 1 μT	Continuous for 18 weeks	Effects on sperm count, weights of testes, seminal vesicles, preputial glands	No effect on the weight of testes. Significant reduction of the weight of seminal vesicles and preputial glands. Significant reduction in sperm count		[31]
Rat Sprague–Dawley	50 Hz	1.35 ± 0.018 mT	2 h/day, 7days/week for 2 months	Sperm count, morphological changes of testes	No significant alterations were observed	Funding not mentioned	[32]
Rat Wistar albino♀♂	50 Hz	1 mT (mean value)	3 h/day for 50 or 100 days	Morphological evaluation of uterus and ovaries	Ultrastructural alterations in germinal epithelium of ovaries in the experimental group (50 days) as well as in tunica albuginea (100 days)	Ambiguous observations in the uterus	[33]
Rat Sprague–Dawley♂♀	20 kHz	6.25 mT	8 h/day, 5 days/week for 90 days	Histopathological examination of various organs	No differences were seen in testis and ovary		[34]

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Table 1 (*Continued*)

Animal species	Exposure frequency	Exposure parameters	Exposure duration	Endpoint	Results	Comments	Reference
Rat Wistar ♂♀	50 Hz		3 weeks *in utero* and 5 weeks postnatal	Testes	Morphological changes in the boundary tissue of the seminiferous tubules		[35]
Rat Sprague–Dawley♀♂	20 kHz sine waves	6.25 mT	8 h/day for 12 or 18 months	Histopathological examination of various organs	No differences were seen in testis and ovary		[36]
Rat Wistar	30–300 GHz	>0.3 mW/cm^2	30 min for 63 days	Spermatogenesis	Morphological changes in spermatozoa	Scanty data presentation	[37]
Rat Wistar	50 Hz		8 h/day for 8 months	Histological evaluation of testes	Mean seminiferous tubule diameter and testicular weight were significantly lower in exposed group. Histologic damage score was threefold in experimental group versus control		[38]

A special topic, the effects of EMF from power lines on avian reproductive biology, was reviewed by Fernie and Reynolds [24]. Krewski et al. [25], reviewed studies referring to various disciplines regarding the effects of RF. The included literature was published between 2001 and 2003. A novelty of this paper, was a discussion of the reports of various authorities and committees about the potential health risks associated with exposure to RF fields. A gap in the literature regarding the biological effects of EMF in the intermediate frequency range was covered by the review of Shigemitsu et al. [26].

During the last decade, many reports from authorities (local, national and international) and expert panels have been uploaded on the web [2].

It is suggested that the reader refer to the above-mentioned review articles and electronic addresses, in order to assemble a more complete and detailed view of the biological effects of EMF.

3. Male genital system

The testes are very important organs situated externally to the body and enclosed by the scrotum. The testicular parenchyma is the site of an intense proliferation and differentiation of the germinal cells that will become the sperm cells. The testes are very sensitive to temperature variations and for this reason the scrotum, which contains the testicular parenchyma, has a specialized contractile structure.

Studies that have evaluated EMF effects (mainly LF) on the genital systems of the vertebrates are summarized in Table 1.

Regarding mobile telephony, the first study conducted by Dasdag et al. [39] investigated whether there are adverse effects due to microwave exposure emitted by cellular phones in male Wistar albino rats. The animals ($n = 18$) were divided in three groups (control, standby exposed group, speech exposed group). Specific energy absorption rate (SAR) was 0.141 W/kg. Rats in the experimental groups were exposed for 2 h/day for 1 month in standby position, whereas phones were turned to the speech position three times for 1 min. The decrease of epididymal sperm counts in the speech groups was not found to be significant. Differences in terms of normal and abnormal sperm forms were not observed. Histological changes were especially observed in the testes of rats in the speech group. Seminiferous tubular diameter of rat testes in the standby and speech groups was found to be lower than the sham group. Rectal temperatures of rats in the speech group were found to be higher than the sham and standby groups. The rectal temperatures of rats before and after exposure were also found to be significantly higher in the speech group.

The same group of authors [40], failed to reproduce the results of their previous work. Sixteen Sprague–Dawley rats were separated into two groups (control, experimental). They were exposed to 890–915 MHz pulsed wave (PW) daily for

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20 min/day for 1 month. For 250 mW average radiated power, SAR was 0.52 W/kg. No differences were observed in the percentages of epididymal normal and abnormal sperms, the epididymal sperm count, as well as in the seminiferous tubule diameter between control and experimental groups. Also, the testicular biopsy score as evaluated by Johnson's scale did not differ significantly.

Aitken et al. [41] assessed the testis of mice irradiated with 900 MHz in a waveguide, with an exposure condition SAR 90 mW/kg for 7 days at 12 h/day. The authors did not observe abnormalities regarding the sperm number, morphology and vitality. However, they reported significant damage to the mitochondrial genome as well as to the nuclear-globin locus.

Results similar to a previous study [39] regarding the diameter of the seminiferous tubules of rat testes were obtained by Ozguner et al. [42]. During the experiment, 20 male Sprague–Dawley rats (5 months of age) were either exposed to 900 MHz CW (average power density 1 ± 0.4 mW/cm^2) or not (control group). Rats exposed 30 min/day, for 5 days/week for 4 weeks. The authors also did not observe significantly different values of weight of testes, testicular biopsy score count and the percentage of interstitial tissue. However, the mean height of the germinal epithelium was found decreased in the group of rats that had been irradiated.

Forgács et al. [43] repeatedly exposed male NMRI mice to 1800 MHz GSM like microwave radiation at 0.018–0.023 W/kg whole body SAR. 11–12 sham exposed and 11–12 exposed mice were used. The animals were exposed ten times (over 2 weeks) and the duration of exposure was 2 h/day. No microwave exposure-related morphological alterations were found in testis, epididymis and prostate.

Adult male rats were examined after exposure at subcrhronic exposure to RF emitted from a conventional cell phone on their testicular function. Sixteen Wistar rats were used at age 30 days. The animals were exposed for 1 h daily during 11 weeks. The experimental group ($n = 8$) was exposed to 1835–1850 MHz at 0.04–1.4 mW/cm^2. Total body weight and absolute and relative testicular and epididymal weights did not change significantly. Epididymal sperm count was not significantly different between the groups. Regarding the histomorphological endpoints of the study, no difference was found between the experimental and control arm [44].

The effect of cellular phone emissions on sperm characteristics in 16 Sprague–Dawley rats were studied [45]. The laboratory animals were divided in two groups (experimental, control) and exposed to four cell phones which had a personal communications service code division multiple access frequency band of 1.9 GHz (800 MHz digital and 800 MHz analog). The rats received daily (3 h–30 min rest–3 h) cell phone exposure for 18 weeks. The SAR ranged from 0.9 to 1.80 W/kg whereas the power from 0.00001 to 0.607 W, according to the specific mode of function. The authors analyzed the morphology of the sperm cells from epididymis of rats. The percentage of deformities for the experimental group was 34.3% and the percentage of deformities for the control group was 32.1%. This difference in the occurrence of deformities between the two groups was not statistically significant ($p > .05$) through a paired t test. The total sperm counts from the testes were not significantly different between the two groups. None of the temperature differences between the two groups were statistically significant.

Sixteen Sprague–Dawley rats were used to evaluate the bcl-2 protein (an anti-apoptotic protein) in rat testes. The experimental group ($n = 8$) was exposed to commercial (GSM) cellular phones irradiation for 20 min/day for 1 month. Average power density was measured at 0.047 mW/cm^2 and SAR levels changed between 0.29 and 0.87 W/kg. The testes were investigated by means of immunohistochemistry. No difference was observed between testes sections of the sham and experimental groups in terms of bcl-2 staining. These results indicate that the radiation emitted from 900 MHz cellular phones did not alter the anti-apoptotic protein in the testes of rats [46].

In order to investigate the apoptosis-inducing effect of mobile phone exposure on spermatogonia in seminiferous tubules, 31 Wistar albino male rats were divided in three groups such as cage control ($n = 10$), sham exposed ($n = 7$), and experimental ($n = 14$). The 2 h/day (7 days/week) exposure of 900 MHz radiation (power density 0.012–0.149 mW/cm^2 and SAR 0.07–0.57 W/kg) over a period of 10 months was evaluated by means of immunohistochemistry. The long-term radiation did not affect the active caspace-3 levels in testes of rats. Caspace-3 is a typical feature of apoptosis [47].

4. Female genital system

Studies on the impact of RF in the female genital system are scarce. Two studies were conducted in order to evaluate the effects on endometrial apoptosis and the ameliorating effects of a combination of vitamin E and C against EMF damage.

Oral et al. [48], exposed sexually mature female rats (16 weeks old) to 900 MHz radiation, 30 min/day for 30 days. Twenty-four Wistar albino rats were divided in three groups (sham exposed, EMF exposed, EMF exposed treated with vitamin C and E). The animals were exposed at 1.04 mW/cm^2 (SAR 0.016–4 W/kg). The effect of microwaves was examined in rat endometrium by means of immunohistochemistry. Endometrial apoptosis was observed. Guney et al. [49], repeated the experiment with the addition of another group (control). Histological changes in endometrium, diffuse and severe apoptosis in the endometrial surface, epithelial and glandular cells were reported regarding the group exposed to EMF. Also, eosinophilic leucocyte and lymphocyte infiltration were seen in the endometrial stroma.

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Table 2
Overview of investigations on EMF effects on animal development.

Animal species	Exposure frequency	Exposure parameters	Exposure duration	Endpoint	Results	Comments	Reference
Rat Sprague–Dawley	50 Hz	7, 70, 350 mT	22 h/day during 0–7 or 8–15 day of gestation	Effects on teratogenicity and embryonic development	No differences regarding embryonic deaths, fetal weight and teratogenicity		[50]
Mouse ICR	50 Hz	Sham (0.1–1 μT), 0.5, 5 mT	9 weeks♂ 2 weeks♀ prior to mating	Effects on teratogenicity and embryonic development	No differences regarding embryonic deaths, fetal weight and teratogenicity		[51]
Mouse Swiss Webster	0 Hz–25 MHz		1 week beginning from the 18th day of pregnancy	Morphological changes in brain, thymus, adrenal gland during embryonic development	Pathological changes were observed in the neonates		[52]
Rat Sprague–Dawley	60 Hz	0 (sham group), 5, 83.3, 500 mT.	22 h/day during 6–20 day of gestation	Developmental toxicity	No differences regarding embryonic deaths, fetal weight and teratogenicity		[53]
Chicken	50 Hz	1.33–7.32 mT	24 h	Effects on teratogenicity and embryonic development	Significant difference in the percentage of abnormal embryos versus control was found in 4.19, 5.32, 5.86, and 6.65 densities. Some embryos with extra ribs, defects in ribs and vertebrae, anuria and abnormal beaks were observed	Funding not mentioned	[54]
Mouse ICR	20 kHz	6.5 mT	8 h/day from 2.5 to 15.5 days post-coitum	Effects on teratogenicity and embryonic development	No statistically significant differences in the number of implantation, embryonic death, resorption, growth retarded fetuses, external and skeletal abnormalities		[55]
Chicken Leghorn HR7	50 Hz	1 μT, 500 μT, 1 mT	Continuous for 15 or 21 days	Effects on embryo/fetus	At 15 days of incubation body weight was significantly lower versus controls. At 21 days of incubation the body weight and cranial diameters were smaller versus control. No differences in brain weight were observed in all groups	Funding not mentioned	[56]
Mouse ♀	Static magnetic field	400 mT	6 min/day from 7.5 to 14.5 day of pregnancy	Teratogenic effects	Polydactylism, abdominal fissure, fused ribs, vestigial 13th rib, brain hernia, curled tail		[57]
Mouse ♀	50 Hz	1.2 mT	8 h/day during pregnancy	Body weight of dams, development of offspring	Fetal loss, malformed fetuses, retardation of growth of the offspring in the first 2 weeks after birth	Article in chinese	[58]
Chicken White Leghorn eggs	50 Hz	1.33–7.32 mT	4 days	Morphological evaluation of embryos/fetuses	Abnormal brain cavities, spina bifida, monophthalmia, ocular defects and growth retardation		[59]

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5. Developmental effects

The critical phases in the dynamic process of development take place mainly *in utero* (mammals) or *in ovo* (birds) i.e. during the embryonic period. The main bulk of investigations were performed regarding the possible effects on animals after irradiation, during *in utero* or *in ovo* development. The effects on development are determined by endpoints such as weight gain, congenital malformations, resorptions, and number of litters. These endpoints will be considered for various exposure conditions.The effects of EMF (mainly LF) on animal development are summarized in Table 2. Egg production was reduced (8%) when young laying hens have been continuously exposed to CW 915 MHz with an incident power of 800 mW during the first 2.5 weeks, 0 mW during the following week and 200 mW for the rest of experiment. Hatching of fertile and total eggs was not significantly influenced. No macroscopic malformations were observed in the chicks or dead embryos [60].

Jensh et al. [61] irradiated pregnant Wistar albino rats at a power density level of 10 mW/cm^2, at a frequency of 915 MHz and average SAR 3.57 W/kg. The animals were exposed for 6 h/day from day 1 to day 21 of gestation. No significant teratogenic signs were observed regarding the resorption rate, malformation rate, mean litter size, fetal weight and number of live and dead fetuses. The experiment was repeated and extended in order to analyze the embryonic and postnatal development of offspring [62]. Eleven pregnant rats were irradiated and 19 rats were used as control animals. All animals delivered and raised their offspring (F_{1a}) until weaning at 30 days of age. Ten days later females were rebred and teratologic evaluation was conducted on the resultant F_{1b} fetuses. At 90 days of age, reproductive capability was evaluated and a standard teratologic analysis performed on the resultant F_2 offspring. No significant morphologic changes were revealed.

Pregnant rats were exposed at 970 MHz for 22 h/day from the 1st to 19th day of pregnancy [63]. The SAR values varied from 0.07, 2.4 and 4.8 W/kg. The embryo mortality, fetal weight, skeletal ossification, as well as maternal fertility were evaluated. The exposure with SAR 4.8 W/kg caused reduced (−12%) fetal body weight versus the control. All the other examined parameters were not significantly different.

Klug et al. [64] exposed rat embryos (9.5 days old) for up to 36 h to 900 MHz. The modulation frequency was fixed at 215 Hz and the SAR values were calculated at 0.2, 1 and 5 W/kg. The endpoints of the experiment were crown-rump length, number of somites as well as embryonic malformations. No significant changes were observed on the growth and differentiation parameters of the embryos. Magras and Xenos [65] investigated the possible effects of radiofrequency radiation on prenatal development in mice. The study consisted of *in vivo* experiments at several places around an "antenna park" where the frequency emissions ranged from 88.5 to 950 MHz. At these locations RF power densities between 168 and 1053 nW/cm^2 were measured. Twelve pairs of mice, divided in two groups, were placed in locations of different power densities and were repeatedly mated five times. One hundred eighteen newborns were collected. They were measured, weighed, and examined macro- and microscopically. A progressive decrease in the number of newborns per dam was observed, which ended in irreversible infertility. The prenatal development of the newborns, however, evaluated by the crown-rump length, the body weight, and the number of the lumbar, sacral, and coccygeal vertebrae, was improved. Wistar albino rats [15] were exposed through pregnancy for 6 h each day to CW 915 MHz radiation at a power density level of 10 mW/cm^2. Teratologic evaluation included the following parameters: mean litter size, maternal organ weight and organ weight/body weight ratios, body weight ratios of various organs (brain, liver, kidneys, and ovaries), number of resorptions and resorption rate, number of abnormalities and abnormality rate, mean term fetal weight. Mothers were rebred, and the second, unexposed litters were evaluated for teratogenic effects. Animals exposed to 915 MHz did not exhibit any consistent significant alterations in any of the above parameters.

Wistar rats were continuously exposed [66] during pregnancy to a low-level (0.1 mW/cm^2) 900 MHz, 217 Hz pulse modulated EMF. Whole body average SAR values for the freely roaming, pregnant animals were measured in models; they ranged between 17.5 and 75 mW/kg. No differences between exposed and sham exposed dams or offspring were recorded in terms of litter size, evolution of body mass and developmental landmarks of litter mates. The effects of microwaves emitted by cellular phones on birth weights of rats were investigated by Dasdag et al. [67]. Thirty-six Wistar albino rats were divided into four groups. Each experimental or sham exposed group comprised six males or 12 females. The rats were exposed at 890–915 MHz (SAR 0.155 W/kg). Males were exposed daily for 3 × 1 min during 2 h/day for 1 month. Females were exposed in the same way until they gave birth. When the offspring became adult the experiment was repeated on them. No significant differences were observed between rectal temperatures in the sham and experimental groups. The birth weight of offspring in the experimental group was significantly lower than in the sham exposed group. However in the next generation of rats all parameters investigated were normal. Pregnant Sprague–Dawley rats were exposed [68] to ultra wide band (UWB) 0.1–1 GHz radiation in order to determine if teratological changes occur in rat pups as a result of (1) daily UWB exposures during gestation days 3 ± 18, or (2) as a result of both prenatal and postnatal (10 days) exposures. Dams were exposed either to (I) UWB irradiation with average whole body specific absorption rate 45 mW/kg (II) sham irradiation or (III) a positive control. Offspring were examined regarding litter size, sex-ratios, weights, coat appearance, and tooth eruption. The pups postnatally exposed were examined for hippocampal morphology. Generally, no significant differences were found between the exposed and sham group. The medial-to-lateral length of the hippocampus was significantly longer in the

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Table 3
Summary of animal studies on effects of EMF (related to mobile telephony), on reproduction and development.

Animal species	Exposure frequency	Endpoint	Effect	Reference
Chicken	915 MHz	Development	No	[60]
Rat	915 MHz	Development	No	[61]
Rat	915 MHz	Development	No	[62]
Rat	970 MHz	Development	No	[63]
Rat	915 MHz	Development	No	[15]
Rat	900 MHz	Development	No	[64]
Mouse	88.5–950 MHz	Fertility/development	Yes/no	[65]
Rat	890–915 MHz	Testes	Yes	[39]
Rat	900 MHz	Development	No	[66]
Rat	0.1–1 GHz	Development	No	[68]
Rat	890–915 MHz	Development	Yes	[67]
Chicken	900 MHz	Development	Yes	[69]
Rat	890–915 MHz	Testes	No	[40]
Chicken		Development	Yes	[70]
Rat	900 MHz	Testes	No	[42]
Mouse	900 MHz	Testes	No	[41]
White stork	900–1800 MHz phone mast	Reproduction	Yes	[74]
Chicken	900 MHz	Kidney development	Yes	[71]
Mouse	1800 MHz	Testes	No	[43]
Rat	900 MHz	Endometrium	Yes	[48]
Rat	900 MHz	Brain development	No	[72]
Rat	1835–1850 MHz	Testes	No	[44]
Rat	1.9 GHz	Sperm	No	[45]
Tit	1200–3000 MHz	Reproduction	No	[75]
Rat	900 MHz	Endometrium	Yes	[49]
Chicken	900 MHz	Development	Yes	[73]
Rat	900 MHz	Testes	No	[46]
Rat	900 MHz	Testes	No	[47]

UWB-exposed pups than in the sham exposed animals but could not correlated with neurological dysfunction. The male offspring exposed *in utero* to UWB mated significantly less frequently than sham exposed males, but when they did mate there was no difference in fertilization and offspring numbers from the sham group.

Bastide et al. [69] reported chicken embryo mortality from day 7 to day 11 of incubation. This mortality reached 64% compared to 11% in controls. The maximum level of embryonic mortality was observed in the eggs placed near the telephone.

Chicken embryos were exposed to EMF from GSM mobile phone during the embryonic development [70]. The embryo mortality rate in the incubation period increased to 75% versus 16% in control group.

Ingole and Ghosh [71] studied by means of light microscopy the developmental effects on the avian kidney of radiation, from a cell phone handset (900 MHz frequency, power of 2 W and SAR of 0.37 W/kg). The authors reported morphological alterations on the epithelium of the renal tubules as well as of the renal corpuscles in E6, E8 and E10 chicken embryos.

The possible impact of cell phone radiation in the developing central nervous system of male Wistar rats was examined [72]. The animals were exposed to 900 MHz signal for 2 h/day on 5 days/week. After 5 weeks of exposure at whole body average SAR of 0.3 or 3 W/kg or sham exposure no degenerative morphological changes were found.

The results about the effects of exposing fertilized chicken eggs to a mobile phone over the entire period of incubation were published recently [73]. In this study, a series of 4 incubations were employed. During each incubation, 4 groups were used (control I, control II, experimental, sham). In the experimental group, the cell phone in call position was placed near ($\leq$25 cm) the eggs, whereas in the sham group the cell phone in off position was placed 1.5 m away from the exposed group. A significantly higher percentage of embryo mortality was observed in the experimental compared to the sham group in 2 of the 4 incubations. The lethal effects of embryo development in the experimental group were mainly observed between the 9th and 12th day of incubation.

Another issue that in recent years has attracted the attention of scientists is the effects of radiation from RF antennas on the biology of wild birds.

Balmori [74] investigated the possible effects of EMF from phone masts on a population of White stork (*Ciconia ciconia*). The total productivity in the nests located within 200 m of antennas was 0.86 ± 0.16 versus 1.6 ± 0.14 for those located further than 300 m. Another interesting observation, was that, 40% of the nests within 200 m of the antennae never had any chicks, while only 3.3% located further than 300 m never had chicks.

The influence of a military radar station [75] emitting pulsed modulated microwave radiation of 1200–3000 MHz was examined in tits (*Parus* sp). Experimental nest-boxes

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were either exposed to a mean level of 3.41 ± 1.38 or $1.12 \pm 0.84\ W/m^2$. For control nest-boxes the exposure ranged from 0.001 to 0.01 W/m^2. No statistically significant differences in the number of eggs or in the number of nestlings were observed between the two series (exposed, control) of tits.

6. Conclusions

The EMF were, are and will be a part of our life. The progress of science will provide the world with new EMF emitting technologies and subsequently with new problems. The monitoring of literature on this scientific field shows a shift of research which follows exactly the new technologies. The era of mobile telephony is beginning.

The evaluation of the possible effects of EMF on the living organism is a complex process that needs the combined contributions of many scientific disciplines. Due to the need for expertise in many different sciences, together with the technical problems of radiation studies, many times the published results are considered deficient in certain aspects. This is inevitable, and not an indication of poor quality. The inability to observe a biological effect in a particular study does not necessarily mean that such effect or/and adverse health effect is not present.

The vertebrate animal studies summarized in the present paper do not suggest strong effects of LF EMF on the male genital system. However, some studies on the development of animals, showed sensitivity, mainly observed in chickens. There is no convincing evidence from studies of mammals (Table 3), that exposure to EMF at levels associated with mobile telecommunications could be harmful for embryonic or postnatal development or for male fertility. On the other hand, the birds appeared to be more sensitive. The effects of EMF on the female genital system need further attention, since two experimental studies cannot lead to definitive conclusions.

The positive findings of the experimental studies with vertebrate animals are mainly attributed to the thermal effects of EMF. No valid evidence was found for the occurrence of non-thermal effects. However the non-thermal mechanisms must be the next target of the research.

The majority of reviewed studies were conducted in laboratories. This fact cannot represent the realistic situation of cell phone communication. On the other hand, the *in vivo* and simultaneously *in situ* studies are very scarce. Only Magras and Xenos conducted an *in situ* experiment which took place near an antenna park. That is because this kind of experiment is very difficult to carry out, and interaction with other exogenous factors could change the results.

One particular deficiency in most studies is that they describe experiments with acute or short-term exposure of animals on EMF. Experiments are needed to perform long-term exposure in order to demonstrate the chronic impact of EMF.

Another point that must be elucidated is that the majority of experimental animals used were small rodents (mice and rats), as well as chicken embryos. Further research is needed with the use of bigger animals such as dog and sheep.

The radiations emitted from masts that are situated in many rural and sylvatic areas could be possibly pathogenic in the wild animals. The wild animal populations could be candidate "experimental material" for closer observation of the possible effects of EMF on vertebrate models.

An important and intriguing aspect of the research is the possible role of the combination of RF with other pollutants such as chemical substances and other forms of radiation, as well as the interaction with drugs.

The potential health effects of EMF should be continually reassessed as new research results become available. EMF exposure guidelines also need to be updated or reconsidered as new scientific information on radiation and health risks is produced. However, additional studies might increase our understanding of the sensitivity of organisms to EMF.

References

[1] J. Juutilainen, Developmental effects of electromagnetic fields, Bioelectromagnetics 7 (2005) S107–S115.
[2] P.A. Valberg, T.E. van Deventer, M.H. Repacholi, Workgroup report: base stations and wireless networks-radiofrequency (RF) exposures and health consequences, Environ. Health Perspect. 115 (2007) 416–424.
[3] M.H. Repacholi, Health risks from the use of mobile phones, Toxicol. Lett. 120 (2001) 323–331.
[4] L.J. Challis, Mechanisms for interaction between RF fields and biological tissue, Bioelectromagnetics 7 (2005) S98–S106.
[5] B.C.A. Windle, On certain early malformations of the embryo, J. Anat. Physiol. 27 (1893) 436–453.
[6] B.C.A. Windle, On the effects of electricity and magnetism on development, J. Anat. Physiol. 29 (1895) 346–351.
[7] H.J. Cook, N.H. Steneck, A.J. Vander, G.L. Kane, Early research on the biological effects of microwave radiation: 1940–1960, Ann. Sci. 37 (1980) 323–351.
[8] W.M. Leach, Genetic, growth and reproductive effects of microwave radiation, Bull. N.Y. Acad. Med. 56 (1980) 249–257.
[9] B. Algers, K. Hennichs, Biological effects of electromagnetic fields. A review, Vet. Res. Commun. 6 (1983) 265–279.
[10] T.E. Bryan, R.P. Gildersleeve, Effects of nonionizing radiation on birds, Comp. Biochem. Physiol. 89A (1988) 511–530.
[11] E. Berman, L. Chacon, D. House, Development of chicken embryos in a pulsed magnetic field, Bioelectromagnetics 11 (1990) 169–187.
[12] J. Juutilainen, Effects of low-frequency magnetic fields on embryonic development and pregnancy, Scand. J. Work Environ. Health. 17 (1991) 149–158.
[13] N. Chernoff, J.M. Rogers, R. Kavet, A review of the literature on potential reproductive and developmental toxicity of electric and magnetic fields, Toxicology 74 (1992) 91–126.
[14] R.L. Brent, W.E. Gordon, W.R. Bennett, D.A. Beckman, Reproductive and teratologic effects of electromagnetic fields, Reprod. Toxicol. 7 (1993) 535–580.
[15] R.P. Jensh, Behavioral teratological studies using microwave radiation: is there an increased risk from exposure to cellular phones and microwave ovens? Reprod. Toxicol. 11 (1997) 601–611.

Please cite this article in press as: A.F. Pourlis, Reproductive and developmental effects of EMF in vertebrate animal models, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.01.010

[16] L. Verschaeve, A. Maes, Genetic, carcinogenic and teratogenic effects of radiofrequency fields, Mutation Res. 410 (1998) 141–165.
[17] H. Huuskonen, M.-L. Lindbohm, J. Juutilainen, Teratogenic and reproductive effects of low-frequency magnetic fields, Mutation Res. 410 (1998) 167–183.
[18] R.L. Brent, Reproductive and teratologic effects of low-frequency electromagnetic fields: a review of *in vivo* and *in vitro* studies using animal models, Teratology 59 (1999) 261–286.
[19] M.E. O'Connor, Mammalian teratogenesis and radiofrequency fields, Proc. IEEE 68 (1980) 56–60.
[20] L.N. Heynick, J.H. Merritt, Radiofrequency fields and teratogenesis, Bioelectromagnetics 6 (2003) (2003) S174–S186.
[21] J. Juutilainen, Developmental effects of extremely low frequency electric and magnetic fields, Radiat. Prot. Dosim. 106 (2003) 385–390.
[22] W. Löscher, Die Auswirkungen electromagnetischer Felder von Mobilfunksendeanlagen auf Leistung, Gesunheit und Verhalten landwirtschaftlicher Nutzitere: Eine Bestandsaufnahme, Der practiche Tierarzt 84 (2003) 850–863.
[23] R.D. Saunders, C.D. McCaig, Developmental effects of physiologically weak electric fields and heat: an overview, Bioelectromagnetics 7 (2005) S127–S132.
[24] K.J. Fernie, S.J. Reynolds, The effects of electromagnetic fields from power lines on avian reproductive biology and physiology: a review, J. Toxic Environ. Health B 8 (2005) 127–140.
[25] D. Krewski, B.W. Glickman, R.W.Y. Habash, B. Habbick, W.G. Lotz, R. Mandeville, F.S. Prato, T. Salem, D.F. Weaver, Recent advances in research on radiofrequency fields and health: 2001–2003, J Toxic Environ. Health B 10 (2007) 287–318.
[26] T. Shigemitsu, K. Yamazaki, S. Nakasono, M. Kakkikawa, A review of studies of the biological effects of electromagnetic fields in the intermediate frequency range, IEEJ Trans. Electr. Electron. Eng. 2 (2007) 405–412.
[27] A. Elbetieha, M.A. Al-Akhras, H. Darmani, Long-term exposure of male and female mice to 50 Hz magnetic field: effects on fertility, Bioelectromagnetics 23 (2002) 168–172.
[28] J.A. Heredia-Rojas, D.E. Caballero-Hernandez, A.O. Rodriguez-De La Fuente, G. Ramos-Alfano, L.E. Rodriguez-Flores, Lack of alterations on meiotic chromosomes and morphological characteristics of male germ cells in mice exposed to a 60 Hz and 2.0 mT magnetic field, Bioelectromagnetics 25 (2004) 63–68.
[29] J.S. Lee, S.S. Ahn, K.C. Jung, Y.W. Kim, S.K. Lee, Effects of 60 Hz electromagnetic field exposure on testicular germ cell apoptosis in mice, Asian J. Androl. 6 (2004) 29–34.
[30] M.K. Chung, S.J. Lee, Y.B. Kim, S.C. Park, D.H. Shin, S.H. Kim, J.C. Kim, Evaluation of spermatogenesis and fertility in F1 male rats after *in utero* and neonatal exposure to extremely low frequency electromagnetic fields, Asian J. Androl. 7 (2005) 189–194.
[31] M.A. Al-Akhras, H. Darmani, A. Elbetieha, Influence of 50 Hz magnetic field on sex hormones and other fertility parameters of adult male rats, Bioelectromagnetics 27 (2006) 127–131.
[32] M.Z. Akdag, S. Dasdag, F. Aksen, B. Isik, F. Yilmaz, Effect of ELF magnetic fields on lipid peroxidation, sperm count, p53 and trace elements, Med. Sci. Monit. 12 (2006) 366–371.
[33] F. Aksen, M.Z. Akdag, A. Ketani, B. Yokus, A. Kaya, S. Dasdag, Effect of 50 Hz 1 mT magnetic field on the uterus and ovaries of rats, Med. Sci. Monit. 12 (2006) 215–220.
[34] S.H. Kim, H.J. Lee, S.Y. Choi, Y.M. Gimm, J.K. Pack, H.D. Choi, Y.S. Lee, Toxicity bioassay in Sprague–Dawley rats exposed to 20 kHz triangular magnetic field for 90 days, Bioelectromagnetics 27 (2006) 105–111.
[35] A.A. Khaki, R.S. Tubbs, M.M. Shoja, J.S. Rad, A. Khaki, R.M. Farahani, S. Zarrintan, T.C. Nag, The effects of an electromagnetic field on the boundary tissue of the seminiferous tubules of the rat: a light and transmission electron microscope study, Folia Morphol. 65 (2006) 188–194.
[36] H.J. Lee, S.H. Kim, S.Y. Choi, Y.M. Gimm, J.K. Pack, H.D. Choi, Y.S. Lee, Long-term exposure of Sprague–Dawley rats to 20 kHz triangular magnetic fields, Int. J. Radiat. Biol. 82 (2006) 285–291.
[37] T.I. Subbotina, O.V. Tereshkina, A.A. Khadartsev, A.A. Yashin, Effect of low-intensity extremely high frequency radiation on reproductive function in Wistar rats, Bull. Exp. Biol. Med. 142 (2006) 189–190.
[38] S. Erpek, M.D. Bilgin, E. Dikicioglu, A. Karul, The effects of low frequency electric field in rat testis, Revue Méd. Vét 158 (2007) 206–212.
[39] S. Dasdag, M.A. Ketani, Z. Akdag, A.R. Ersay, I. Sari, O.C. Demirtas, M.S. Celik, Whole body microwave exposure emitted by cellular phones and testicular function of rats, Urol. Res. 27 (1999) 219–223.
[40] S. Dasdag, M.Z. Akdag, F. Aksen, F. Yilmaz, M. Bashan, M.M. Dasdag, M.S. Celik, Whole body exposure of rats to microwaves emitted from a cell phone does not affect the testes, Bioelectromagnetics 24 (2003) 182–188.
[41] R.J. Aitken, L.E. Bennetts, D. Sawyer, A.M. Wiklendt, B.V. King, Impact of radio frequency electromagnetic radiation on DNA integrity in the male germ line Inter, J. Androl. 28 (2005) 171–179.
[42] M. Ozguner, A. Koyu, G. Cesur, M. Ural, F. Ozguner, A. Gokcimen, N. Delibas, Biological and morphological effects on the reproductive organ of rats after exposure to electromagnetic field, Saudi Med. J. 26 (2005) 405–410.
[43] Z. Forgács, Z. Somosy, G. Kubinyi, J. Bakos, A. Hudák, A. Surján, G. Thuróczy, Effects of whole body 1800 MHz GSM-like microwave exposure on testicular stereidogenesis and histology in mice, Reprod. Toxicol. 22 (2006) 111–117.
[44] E.P. Ribeiro, E.L. Rhoden, M.M. Horn, C. Rhoden, L.P. Lima, L. Toniolo, Effects of sub chronic exposure to radio frequency from a conventional cellular telephone on testicular function in adult rats, J. Urol. 177 (2007) 395–399.
[45] J.G. Yan, M. Agresti, T. Bruce, Y.H. Yan, A. Granlund, H.S. Matloub, Effects of cellular phone emissions on sperm motility in rats, Fertil. Steril. 88 (2007) 957–964.
[46] F. Yilmaz, S. Dasdag, M.Z. Akdag, N. Kilinc, Whole body exposure of radiation emitted from 900 MHz mobile phones does not seem to affect the levels of anti-apoptotic bcl-2 protein, Electromagn. Biol. Med. 27 (2008) 65–72.
[47] S. Dasdag, M.Z. Akdag, E. Ulukaya, A.K. Uzunlar, D. Yegin, Mobile phone exposure does not induce apoptosis on spermatogenesis in rats, Arch. Med. Res. 39 (2008) 40–44.
[48] B. Oral, M. Guney, F. Ozguner, N. Karahan, T. Mungan, S. Comlekci, G. Cesur, Endometrial apoptosis induced by a 900 MHz mobile phone: preventive effects of vitamins E and C, Adv. Ther. 23 (2006) 957–973.
[49] M. Guney, F. Ozguner, B. Oral, N. Karahan, T. Mungan, 900 MHz radiofrequency induced histopathologic changes and oxidative stress in rat endometrium: protection by vitamins E and C, Toxicol. Ind. Health 23 (2007) 411–420.
[50] T. Negishi, S. Imai, M. Itabashi, I. Nishimura, T. Sasano, Studies of 50 Hz circularly polarized magnetic fields of up to 350 mT on reproduction and embryo-fetal development in rats: exposure during organogenesis or during preimplantation, Bioelectromagnetics 23 (2002) 369–389.
[51] Y. Ohnishi, F. Mizuno, T. Sato, M. Yasui, T. Kikuchi, M. Ogawa, Effects of power frequency alternating magnetic fields on reproduction and prenatal development of mice, J. Toxicol. Sci. 27 (2002) 131–138.
[52] Z.E. Gagnon, C. Newkirk, J.A. Conetta, M.A. Sama, S. Sisselman, Teratogenic effect of broad-band electromagnetic field on neonatal mice, J. Environ. Sci. Health A Tox. Hazard Subst. Environ. Eng. 38 (2003) 2465–2481.
[53] M.K. Chung, J.C. Kim, S.H. Myung, D.I. Lee, Developmental toxicity evaluation of ELF magnetic fields in Sprague–Dawley rats, Bioelectromagnetics 24 (2003) 231–240.
[54] M.S. Lahijani, K. Sajadi, Development of preincubated chicken eggs following exposure to 50 Hz electromagnetic fields with 1.33–7.32 mT flux densities, Indian J. Exp. Biol. 42 (2004) 858–865.
[55] S.H. Kim, J.E. Song, S.R. Kim, H. Oh, Y.M. Gimm, D.S. Yoo, J.K. Pack, Y.S. Lee, Teratological studies of prenatal exposure of mice to a

Please cite this article in press as: A.F. Pourlis, Reproductive and developmental effects of EMF in vertebrate animal models, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.01.010

20 kHz sawtooth magnetic field, Bioelectromagnetics 25 (2004) 114–117.
[56] O. Roda-Murillo, J.A. Roda-Moreno, M.T. Morente–Chiquero, Effects of low-frequency magnetic fields on different parameters of embryo of *Gallus domesticus*, Electromagn. Biol. Med. 24 (2005) 55–62.
[57] K. Saito, H. Suzuki, K. Suzuki, Teratogenic effects of static magnetic field on mouse fetuses, Reprod. Toxicol. 22 (2006) 118–124.
[58] Y.N. Cao, Y. Zhang, Y. Liu, Effects of exposure to extremely low frequency electromagnetic fields on reproduction of female mice and development of offspring, Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi 24 (2006) 468–470.
[59] M.S. Lahijani, S.E. Nojooshi, S.F. Siadat, Light and electron microscope studies of effects of 50 Hz electromagnetic fields on preincubated chick embryo, Electromagn. Biol. Med. 26 (2007) 83–98.
[60] W.F. Krueger, A.J. Giarola, J.W. Bradley, A. Shrekenhamer, Effects of electromagnetic fields on fecundity in the chicken, Ann. N.Y. Acad. Sci. 247 (1975) 391–400.
[61] R.P. Jensh, I. Weinberg, R.I. Brent, Teratologic studies of prenatal exposure of rats to 915 MHz microwave radiation, Radiat. Res. 92 (1982) 160–171.
[62] R.P. Jensh, W.H. Vogel, R.I. Brent, Postnatal functional analysis of prenatal exposure of rats to 915 MHz microwave radiation, Int. J. Toxicol. 1 (1982) 73–90.
[63] E. Berman, C. Weil, P.A. Philips, H.B. Carter, D.E. House, Fetal and maternal effects of continual exposure of rats to 970 MHz circularly-polarized microwaves, Electromagn. Biol. Med. 11 (1992) 43–54.
[64] S. Klug, M. Hetscher, S. Giles, S. Kohlsman, K. Kramer, The lack of effects of nonthermal RF electromagnetic fields on the development of rat embryos grown in culture, Life Sci. 61 (1997) 1789–1802.
[65] I.N. Magras, T.D. Xenos, RF radiation-induced changes in the prenatal development of mice, Bioelectromagnetics 18 (1997) 455–461.
[66] M. Bornhausen, H. Scheingraber, Prenatal exposure to 900 MHz cell phone electromagnetic fields had no effect on operant-behaviour performances of adult rats, Bioelectromagnetics 21 (2000) 566–574.
[67] S. Dasdag, M.Z. Akdag, O. Ayyildiz, O.C. Demirtas, M. Yayla, C. Sert, Do cellular phones alter blood parameters and birth weight of rats? Electromagn. Biol. Med. 19 (2000) 107–113.
[68] B.L. Cobb, J.R. Jauchem, P.A. Mason, M.P. Dooley, S.A. Miller, J.M. Ziriax, M.R. Murphy, Neural and behavioural teratological evaluation of rats exposed to Ultra-Wideband electromagnetic fields, Bioelectromagnetics 21 (2000) 524–537.
[69] M. Bastide, B.J. Youbicier-Simoa, J.C. Lebecq, J. Giaimis, Toxicologic study of electromagnetic radiation emitted by television and video display screens and cellular telephones on chickens and mice, Indoor Built Environ. 10 (2001) 291–298.
[70] Y. Grigoryev, Biological effects of mobile phone electromagnetic field on chick embryo (Risk assessment using the mortality rate), Radiats. Biol. Radioecol. 43 (2003) 541–543.
[71] I.V. Ingole, S.K. Ghosh, Cell phone radiation and developing tissues in chicken embryo—a light microscopic study of kidneys, J. Anat. Soc. India 55 (2006) 19–23.
[72] T. Kumlin, H. Iivonen, P. Miettenen, A. Junoven, T. van Groen, L. Puranen, R. Pitkäaho, R. Juutilainen, H. Tanila, Mobile phone radiation and the developing brain: behavioral and morphological effects in juvenile rats, Radiat. Res. 168 (2007) 471–479.
[73] F. Batellier, I. Couty, D. Picard, J.P. Brillard, Effects of exposing chicken eggs to a cell phone in 'call' position over the entire incubation period, Theriogenology 69 (2008) 737–745.
[74] A. Balmori, Possible effects of electromagnetic fields from phone masts on a population of White stork (*Ciconia ciconia*), Electromagn. Biol. Med. 24 (2005) 109–119.
[75] L. Rejt, T. Mazgajski, R. Kubacki, J. Kieliszek, E. Sobiczewska, S. Szmigielski, Influence of radar radiation on breeding biology of tits (*Parus* sp), Electromagn. Biol. Med. 26 (2007) 235–238.

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Electromagnetic pollution from phone masts. Effects on wildlife

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Abstract

A review on the impact of radiofrequency radiation from wireless telecommunications on wildlife is presented. Electromagnetic radiation is a form of environmental pollution which may hurt wildlife. Phone masts located in their living areas are irradiating continuously some species that could suffer long-term effects, like reduction of their natural defenses, deterioration of their health, problems in reproduction and reduction of their useful territory through habitat deterioration. Electromagnetic radiation can exert an aversive behavioral response in rats, bats and birds such as sparrows. Therefore microwave and radiofrequency pollution constitutes a potential cause for the decline of animal populations and deterioration of health of plants living near phone masts. To measure these effects urgent specific studies are necessary.

Keywords: Effects on wildlife; Effects on birds; Electromagnetic radiation; Mammals; Microwaves; Mobile telecommunications; Non-thermal effects; Phone masts; Radiofrequencies

1. Introduction

Life has evolved under the influence of two omnipresent forces: gravity and electromagnetism. It should be expected that both play important roles in the functional activities of organisms [1]. Before the 1990's radiofrequencies were mainly from a few radio and television transmitters, located in remote areas and/or very high places. Since the introduction of wireless telecommunication in the 1990's the rollout of phone networks has caused a massive increase in electromagnetic pollution in cities and the countryside [2,3].

Multiple sources of mobile communication result in chronic exposure of a significant part of the wildlife (and man) to microwaves at non-thermal levels [4]. In recent years, wildlife has been chronically exposed to microwaves and RFR (Radiofrequency radiation) signals from various sources, including GSM and UMTS/3G wireless phones and base stations, WLAN (Wireless Local Area Networks), WPAN (Wireless Personal Area Networks such as Bluetooth), and DECT (Digital Enhanced (former European) Cordless Telecommunications) that are erected indiscriminately without studies of environmental impact measuring long-term effects. These exposures are characterized by low intensities, varieties of signals, and long-term durations. The greater portion of this exposure is from mobile telecommunications (geometric mean in Vienna: 73% [5]). In Germany the GSM cellular phone tower radiation is the dominating high frequency source in residential areas [6]. Also GSM is the dominating high frequency source in the wilderness of Spain (personal observation).

Numerous experimental data have provided strong evidence of athermal microwave effects and have also indicated several regularities in these effects: dependence of frequency within specific frequency windows of "resonance-type"; dependence on modulation and polarization; dependence on intensity within specific intensity windows, including super-low power density comparable with intensities from base stations/masts [4,7–9]. Some studies have demonstrated different microwave effects depending on wavelength in the range of mm, cm or m [10,11]. Duration of exposure may be as important as power density. Biological effects resulting from electromagnetic field radiation might depend on dose, which indicates long-term accumulative effects [3,9,12]. Modulated and pulsed radiofrequencies seem to be more effective in producing effects [4,9]. Pulsed waves (in blasts), as well as certain low frequency modulations exert greater

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biological activity [11,13–15]. This observation is important because cell phone radiation is pulsed microwave radiation modulated at low frequencies [8,9].

Most of the attention on possible biological effects of electromagnetic radiation from phone masts has been focused on human health [5,16–21]. The effects of electromagnetic pollution on wildlife, have scarcely been studied [22–25].

The objective of this review is to detail advances in knowledge of radiofrequencies and microwave effects on wildlife. Future research may help provide a better understanding of electromagnetic field (EMF) effects on wildlife and plants and their conservation.

2. Effects on exposed wildlife

2.1. Effects on birds

2.1.1. Effects of phone mast microwaves on white stork

In monitoring a white stork (*Ciconia ciconia*) population in Valladolid (Spain) in vicinity of Cellular Phone Base Stations, the total productivity in nests located within 200 m of antennae, was 0.86 ± 0.16. For those located further than 300 m, the result was practically doubled, with an average of 1.6 ± 0.14. Very significant differences among total productivity were found ($U = 240$; $P = 0.001$, Mann–Whitney test). Twelve nests (40%) located within 200 m of antennae never had chicks, while only one (3.3%) located further than 300 m had no chicks. The electric field intensity was higher on nests within 200 m (2.36 ± 0.82 V/m) than nests further than 300 m (0.53 ± 0.82 V/m). In nesting sites located within 100 m of one or several cellsite antennae with the main beam of radiation impacting directly (Electric field intensity >2 V/m) many young died from unknown causes. Couples frequently fought over nest construction sticks and failed to advance the construction of the nests. Some nests were never completed and the storks remained passively in front of cellsite antennae. These results indicate the possibility that microwaves are interfering with the reproduction of white stork [23]. (Fig. 1)

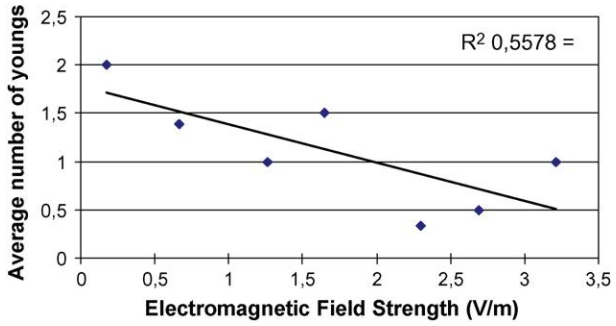

Fig. 1. Average number of youngs and electric field intensity (V/m) in 60 nests of white storks (*Ciconia ciconia*) (Hallberg, Ö with data of Balmori, 2005 [23]).

2.1.2. Effects of phone mast microwaves on house sparrows

A possible effect of long-term exposure to low-intensity electromagnetic radiation from mobile phone (GSM) base stations on the number of house sparrows during the breeding season was studied in Belgium. The study was carried out sampling 150 point locations within six areas to examine small-scale geographic variation in the number of house sparrow males and the strength of electromagnetic radiation from base stations. Spatial variation in the number of house sparrow males was negative and highly significantly related to the strength of electric fields from both the 900 and 1800 MHz downlink frequency bands and from the sum of these bands (Chi-square-tests and AIC-criteria, $P < 0.001$). This negative relationship was highly similar within each of the six study areas, despite differences among areas in both the number of birds and radiation levels. Fewer house sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behavior of house sparrows in the wild [24].

In another study with point transect sampling performed at 30 points visited 40 times in Valladolid (Spain) between 2002 and 2006, counting the sparrows and measuring the mean electric field strength (radiofrequencies and microwaves: 1 MHz to 3 GHz range). Significant declines ($P = 0.0037$) were observed in mean bird density over time, and significantly low bird density was observed in areas with high electric field strength. The logarithmic regression of the mean bird density vs. field strength groups (considering field strength in 0.1 V/m increments) was $R = -0.87$; $P = 0.0001$ According to this calculation, no sparrows would be expected to be found in an area with field strength >4 V/m [25]. (Fig. 2)

In the United Kingdom a decline of several species of urban birds, especially sparrows, has recently happened [26]. The sparrow population in England has decreased in the last 30 years from 24 million to less than 14. The more abrupt decline, with 75% descent has taken place from 1994 to 2002. In 2002, the house sparrow was added to the Red List of U.K. endangered species [27]. This coincides with the rollout of mobile telephony and the

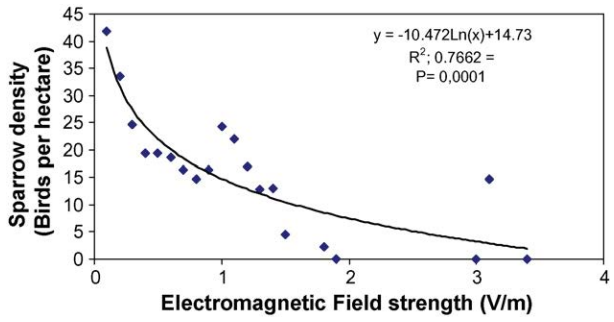

Fig. 2. Mean sparrow density as a function of electric field strength grouped in 0.1 V/m. (Balmori and Hallberg, 2007 [25]).

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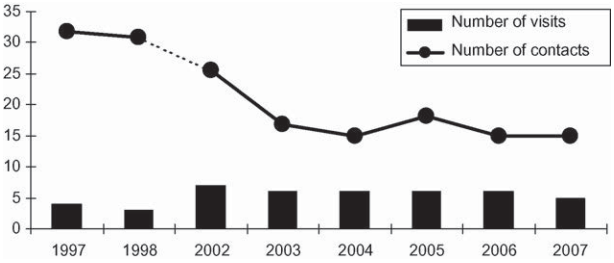

Fig. 3. Annual number of contacts (Mean) for 14 species studied in "Campo Grande" urban park (lack the information of the years 1999–2001).

possible relationship of both circumstances should be investigated.

In Brussels, many sparrows have disappeared recently [28]; similar declines have been reported in Dublin [29]. Van der Poel (cited in Ref. [27]) suggested that sparrows might be declining in Dutch urban centres also.

2.1.3. Effects on the bird community at an urban park

Microwaves may be affecting bird populations in places with high electromagnetic pollution. Since several antennas were installed in proximities of "Campo Grande" urban park (Valladolid, Spain) the bird population has decreased and a reduction of the species and breeding couples has occurred. Between 1997 and 2007, of 14 species, 3 species have disappeared, 4 are in decline and 7 stay stable (Balmori, unpublished data) (Fig. 3). In this time the air pollution (SO2, NO2, CO and Benzene) has diminished.

During the research some areas called "silence areas" contaminated with high microwave radiation (>2 V/m), where previously different couples usually bred and later disappeared, have been found. Several anomalies in magpies (*Pica pica*) were detected: plumage deterioration, locomotive problems (limps and deformations in the paws), partial albinism and melanism, especially in flanks [30]. Recently cities have increased cases of partial albinism and melanism in birds (*Passer domesticus*, *Turdus merula* and *P. pica*) (personal observation).

2.1.4. Possible physiological mechanisms of the effects found in birds

Current scientific evidence indicates that prolonged exposure to EMFs, at levels that can be encountered in the environment, may affect immune system function by affecting biological processes [3,31,32]. A stressed immune system may increase the susceptibility of a bird to infectious diseases, bacteria, viruses, and parasites [33].

The plumage of the birds exposed to microwaves looked, in general, discolorated and lack of shine. This not only occurred in ornamental birds; such as peacocks, but also in wild birds; such as, tits, great tits, house sparrows, etc (personal observation). We must mention that plumage deterioration is the first sign of weakening or illnesses in birds since damaged feathers are a sure sign of stress.

Physiological conditions during exposure minimize microwave effects. Radical scavengers/antioxidants might be involved in effects of microwaves [4].

Microwaves used in cellphones produce an athermal response in several types of neurons of the birds nervous system [34]. Several studies addressed behavior and teratology in young birds exposed to electromagnetic fields [23,25,35–37]. Most studies indicate that electromagnetic field exposure of birds generally changes, but not always consistently in effect or in direction, their behavior, reproductive success, growth and development, physiology and endocrinology, and oxidative stress [37]. These results can be explained by electromagnetic fields affecting the birds' response to the photoperiod as indicated by altered melatonin levels [38].

Prolonged mobile phone exposure may have negative effects on sperm motility characteristics and male fertility as has been demonstrated in many studies made in man and rats [39–46]. EMF and microwaves can affect reproductive success in birds [23,25,35,36,47]. EMF exposure affected reproductive success of kestrels (*Falco sparverius*), increasing fertility, egg size, embryonic development and fledging success but reducing hatching success [35,36].

The radiofrequency and microwaves from mobile telephony can cause genotoxic effects [48–55]. Increases in cytological abnormalities imply long-term detrimental effects since chromosomal damage is a mechanism relevant to causation of birth defects and cancer [55].

Long-term continuous, or daily repeated EMF exposure can induce cellular stress responses at non-thermal power levels that lead to an accumulation of DNA errors and to inhibition of cell apoptosis and cause increased permeability of blood–brain barrier due to stabilization of endothelial cell stress fibers. Repeated occurrence of these events over a long period of time (years) could become a health hazard due to a possible accumulation of brain tissue damage. These findings have important implications with regards to potential dangers from prolonged and repeated exposure to non-ionizing radiation [56,57].

Pulsed magnetic fields can have a significant influence on the development and incidence of abnormalities in chicken embryos. In five of six laboratories, exposed embryos exhibited more structural anomalies than controls. If the data from all six laboratories are pooled, the difference for the incidence of abnormalities in exposed embryos and controls is highly significant [58]. Malformations in the nervous system and heart, and delayed embryo growth are observed. The embryo is most sensitive to exposure in the first 24 h of incubation [58]. An increase in the mortality [59] and appearance of morphological abnormalities, especially of the neural tube [13,60,61] has been recorded in chicken embryos exposed to pulsed magnetic fields, with different susceptibility among individuals probably for genetic reasons. A statistically significant high mortality rate of chicken embryos subjected to radiation from a cellphone, compared to the control group exists [62,63]. In another study eggs exposed to a magnetic

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field intensity of 0.07 T showed embryonic mortality during their incubation was higher. The negative effect of the magnetic field was manifested also by a lower weight of the hatched chicken [64]. Bioelectric fields have long been suspected to play a causal role in embryonic development. Alteration of the electrical field may disrupt the chemical gradient and signals received by embryo cells. It appears that in some manner, cells sense their position in an electrical field and respond appropriately. The disruption of this field alters their response. Endogenous current patterns are often correlated with specific morphogenetic events [65].

Available data suggests dependencies of genotype, gender, physiological and individual factors on athermal microwave effects [4,9]. Genomic differences can influence cellular responses to GSM Microwaves. Data analysis has highlighted a wide inter-individual variability in response, which was replicated in further experiments [4]. It is possible that each species and each individual, show different susceptibility to radiation, since vulnerability depends on genetic tendency, and physiologic and neurological state of the irradiated organism [15,35–37,61,66–68]. Different susceptibility of each species has also been proven in wild birds exposed to electromagnetic fields from high-voltage power lines [47].

2.2. Effects on mammals

2.2.1. Alarm and aversion behavior

Rats spent more time in the halves of shuttle boxes that were shielded from 1.2 GHz. Microwaves irradiation. The average power density was about 0.6 mW/cm^2. Data revealed that rats avoided the pulsed energy, but not the continuous energy, and less than 0.4 mW/cm^2 average power density was needed to produce aversion [69]. Navakatikian & Tomashevskaya [70] described a complex series of experiments in which they observed disruption of rat behavior (active avoidance) from radiofrequency radiation. Behavioral disruption was observed at a power density as low as 0.1 mW/cm^2 (0.027 W/kg). Mice in an experimental group exposed to microwave radiation expressed visible individual panic reaction, disorientation and a greater degree of anxiety. In the sham exposed group these deviations of behavior were not seen and all animals show collective defense reaction [71]. Microwave radiation at 1.5 GHz pulsing 16 ms. At 0.3 mW/cm^2 power density, in sessions of 30 min/day over one month produced anxiety and alarm in rabbits [72].

Electromagnetic radiation can exert an aversive behavioral response in bats. Bat activity is significantly reduced in habitats exposed to an electromagnetic field strength greater than 2 V/m [73]. During a study in a free-tailed bat colony (*Tadarida teniotis*) the number of bats decreased when several phone masts were placed 80 m from the colony [74].

2.2.2. Deterioration of health

Animals exposed to electromagnetic fields can suffer a deterioration of health and changes in behavior [75,76].

There was proof of frequent death in domestic animals; such as, hamsters and guinea pigs, living near mobile telecommunication base stations (personal observation).

The mice in an experimental group exposed to microwave radiation showed less weight gain compared to control, after two months. The amount of food used was similar in both groups [71]. A link between electromagnetic field exposure and higher levels of oxidative stress appears to be a major contributor to aging, neurodegenerative diseases, immune system disorders, and cancer in mammals [33].

The effects from GSM base transceiver station (BTS) frequency of 945 MHz on oxidative stress in rats were investigated. When EMF at a power density of 3.67 W/m^2, below current exposure limits, were applied, MDA (malondialdehyde) level was found to increase and GSH (reduced glutathione) concentration was found to decrease significantly ($P < 0.0001$). Additionally, there was a less significant ($P = 0.0190$) increase in SOD (superoxide dismutase) activity under EM exposure [77].

2.2.3. Problems in reproduction

In the town of Casavieja (Ávila, Spain) a telephony antenna was installed that had been in operation for about 5 years. Then some farmers began blaming the antenna for miscarriages in many pigs, 50–100 m from the antenna (on the outskirts of the town). Finally the topic became so bad that the town council decided to disassemble the antenna. It was removed in the spring 2005. From this moment onwards the problems stopped (C. Lumbreras personal communication).

A Greek study reports a progressive drop in the number of rodent births exposed to radiofrequencies. The mice exposed to 0.168 μW/cm^2 become sterile after five generations, while those exposed to 1.053 μW/cm^2 became sterile after only three generations [22].

In pregnant rats exposed to 27.12 MHz continuous waves at 100 μW/cm^2 during different periods of pregnancy, half the pregnancies miscarried before the twentieth day of gestation, compared to only a 6% miscarriage rate in unexposed controls, and 38% of the viable foetuses had incomplete cranial ossification, compared to less than 6% of the controls. Findings included a considerable increase in the percentage of total reabsorptions (post-implantation losses consequent to RF radiation exposure in the first post-implantation stage). Reduced body weight in the exposed dams reflected a negative influence on their health. It seems that the irradiation time plays an important role in inducing specific effects consequent to radiofrequency radiation exposure [78]. There was also a change in the sex ratio, with more males born to rats that had been irradiated from the time of conception [2]. Moorhouse and Macdonald [79] find a substantial decline in female Water Vole numbers in the radio-collared population, apparently resulting from a male skew in the sex ratios of offspring born to this population. Recruits to the *radio-tracked* population were skewed heavily in favour of males (43:13). This suggests that radio-collaring of females caused male-skewed sex ratios.

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Mobile phone exposure may have negative effects on sperm motility characteristics and male fertility in rats [46]. Other studies find a decrease of fertility, increase of deaths after birth and dystrophic changes in their reproductive organs [11]. Intermittent exposure showed a stronger effect than continuous exposure [4]. Brief, intermittent exposure to low-frequency EM fields during the critical prenatal period for neurobehavioral sex differentiation can demasculinize male scent marking behavior and increase accessory sex organ weights in adulthood [80].

In humans, magnetic field exposures above 2.0 mG were positively associated with miscarriage risk [81]. Exposure of pregnant women to mobile phone significantly increased foetal and neonatal heart rate, and significantly decreased the cardiac output [82].

2.2.4. Nervous system

Microwaves may affect the blood brain barrier which lets toxic substances pass through from the blood to the brain [83]. Adang et al. [84] examined the effect of microwave exposure to a GSM-like frequency of 970 MHz pulsed waves on the memory in rats by means of an object recognition task. The rats that have been exposed for 2 months show normal exploratory behavior. The animals that have been exposed for 15 months show derogatory behavior. They do not make the distinction between a familiar and an unfamiliar object. In the area that received radiation directly from "Location Skrunda Radio Station" (Latvia), exposed children had less developed memory and attention, their reaction time was slower and neuromuscular apparatus endurance was decreased [85]. Exposure to cell phones prenatally and, to a lesser degree, postnatally was associated with behavioral difficulties such as emotional and hyperactivity problems around 7 years of age [86]. Electromagnetic radiation caused modification of sleep and alteration of cerebral electric response (EEG) [87–89]. Microwave radiation from phone masts may cause aggressiveness in people and animals (personal observation).

2.3. Effects on amphibians

Disappearance of amphibians and other organisms is part of the global biodiversity crisis. An associated phenomenon is the appearance of large numbers of deformed amphibians. The problem has become more prevalent, with deformity rates up to 25% in some populations, which is significantly higher than previous decades [90]. Balmori [91] proposed that electromagnetic pollution (in the microwave and radiofrequency range) is a possible cause for deformations and decline of some wild amphibian populations.

Two species of amphibians were exposed to magnetic fields at various stages of development. A brief treatment of early amphibian embryos produced several types of abnormalities [92]. Exposure to a pulsed electromagnetic field produced abnormal limb regeneration in adult Newts [93]. Frog tadpoles (*Rana temporaria*) developed under electromagnetic field (50 Hz, 260 A/m) have increased mortality. Exposed tadpoles developed more slowly and less synchronously than control tadpoles and remain at the early stages for longer. Tadpoles developed allergies and EMF caused changes in blood counts [94].

In a current study exposing eggs and tadpoles ($n = 70$) of common frog (*R. temporaria*) for two months, from the phase of eggs until an advanced phase of tadpole, to four telephone base stations located 140 m away: with GSM system 948.0–959.8 MHz; DCS system: 1830.2–1854.8; 1855.2–1879.8 MHz. and UMTS system: 1905–1910; 1950–1965; 2140–2155 MHz. (electric field intensity: 1.847–2.254 V/m). A low coordination of movements, an asynchronous growth, with big and small tadpoles, and a high mortality (90%) was observed. The control group ($n = 70$), under the same conditions but inside a Faraday cage (metallic shielding component: EMC-reinforcement fabrics 97442 Marburg Technic), the coordination of movements was normal, the development was synchronously and the mortality rate was only 4.2% [95].

2.4. Effects on insects

The microwaves may affect the insects. Insects are the basis and key species of ecosystems and they are especially sensitive to electromagnetic radiation that poses a threat to nature [96].

Carpenter and Livstone [97] irradiated pupae of Tenebrio molitor with 10 GHz microwaves at 80 mW for 20–30 min and 20 mW for 120 min obtained a rise in the proportion of insects with abnormalities or dead. In another study exposing fruit flies (*Drosophila melanogaster*) to mobile phone radiation, elevated stress protein levels (Hsp70) was obtained, which usually means that cells are exposed to adverse environmental conditions ('non-thermal shock') [98]. Panagopoulos et al. [99] exposed fruit flies (*D. melanogaster*) to radiation from a mobile phone (900 MHz) during the 2–5 first days of adulthood. The reproductive capacity of the species reduced by 50–60% in modulated radiation conditions (emission while talking on the phone) and 15–20% with radiation nomodulated (with the phone silent). The results of this study indicate that this radiation affects the gonadal development of insects in an athermal way. The authors concluded that radio frequencies, specifically GSM, are highly bioactive and provoke significant changes in physiological functions of living organisms. Panagopoulos et al. [100] compare the biological activity between the two systems GSM 900 MHz and DCS 1800 MHz in the reproductive capacity of fruit flies. Both types of radiation were found to decrease significantly and non-thermally the insect's reproductive capacity, but GSM 900 MHz seems to be even more bioactive than DCS 1800 MHz. The difference seems to be dependent mostly on field intensity and less on carrier frequency.

A study in South Africa finds a strong correlation between decrease in ant and beetle diversity with the

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electromagnetic radiation exposure (D. MacFadyen, personal communication.). A decrease of insects and arachnids near base stations was detected and corroborated by engineers and antenna's maintenance staff [101]. In houses near antennas an absence of flies, even in summer, was found.

In a recent study carried out with bees in Germany, only a few bees irradiated with DECT radiation returned to the beehive and they needed more time. The honeycomb weight was lower in irradiated bees [102]. In recent years a "colony collapse disorder" is occurring that some authors relate with pesticides and with increasing electromagnetic pollution [96].

The disappearance of insects could have an influence on bird's weakening caused by a lack of food, especially at the first stages in a young bird's life.

2.5. Effects on trees and plants

The microwaves may affect vegetables. In the area that received radiation directly from "Location Skrunda Radio Station" (Latvia), pines (*Pinus sylvestris*) experienced a lower growth radio. This did not occur beyond the area of impact of electromagnetic waves. A statistically significant negative correlation between increase tree growth and intensity of electromagnetic field was found, and was confirmed that the beginning of this growth decline coincided in time with the start of radar emissions. Authors evaluated other possible environmental factors which might have intervened, but none had noticeable effects [103]. In another study investigating cell ultrastructure of pine needles irradiated by the same radar, there was an increase of resin production, and was interpreted as an effect of stress caused by radiation, which would explain the aging and declining growth and viability of trees subjected to pulsed microwaves. They also found a low germination of seeds of pine trees more exposed [104]. The effects of Latvian radar was also felt by aquatic plants. *Spirodela polyrrhiza* exposed to a power density between 0.1 and 1.8 $\mu W/cm^2$ had lower longevity, problems in reproduction and morphological and developmental abnormalities compared with a control group who grew up far from the radar [105].

Chlorophylls were quantitatively studied in leaves of black locust (*Robinia pseudoacacia* L.) seedlings exposed to high frequency electromagnetic fields of 400 MHz. It was revealed that the ratio of the two main types of chlorophyll was decreasing logarithmically to the increase of daily exposure time [106].

Exposed tomato plants (*Lycopersicon esculentum*) to low level (900 MHz, 5 V/m) electromagnetic fields for a short period (10 min) measured changes in abundance of three specific mRNA after exposure, strongly suggesting that they are the direct consequence of application of radio-frequency fields and their similarities to wound responses suggests that this radiation is perceived by plants as an injurious stimulus [107]. Non-thermal exposure to radiofrequency fields induced oxidative stress in duckweed (*Lemna minor*) as well as unespecific stress responses, especially of antioxidative enzymes [108].

For some years progressive deterioration of trees near phone masts have been observed in Valladolid (Spain). Trees located inside the main lobe (beam), look sad and feeble, possibly slow growth and a high susceptibility to illnesses and plagues. In places we have measured higher electric field intensity levels of radiation (>2 V/m) the trees show a more notable deterioration [109]. The tops of trees are dried up where the main beams are directed to, and they seem to be most vulnerable if they have their roots close to water. The trees don't grow above the height of the other ones and, those that stand out far above, have dried tops (Hargreaves, personal communication and personal observation). White and black poplars (*Populus sp*.) and willows (*Salix sp*.) are more sensitive. There may be a special sensitivity of this family exists or it could be due to their ecological characteristics forcing them to live near water, and thus electric conductivity. Other species as *Platanus sp*. and *Lygustrum japonicum,* are more resistant (personal observation). Schorpp [110] presents abundant pictures and explanations of what happens to irradiated trees.

3. Conclusions

This literature review shows that pulsed telephony microwave radiation can produce effects especially on nervous, cardiovascular, immune and reproductive systems [111]:

- Damage to the nervous system by altering electroencephalogram, changes in neural response or changes of the blood–brain barrier.
- Disruption of circadian rhythms (sleep–wake) by interfering with the pineal gland and hormonal imbalances.
- Changes in heart rate and blood pressure.
- Impairment of health and immunity towards pathogens, weakness, exhaustion, deterioration of plumage and growth problems.
- Problems in building the nest or impaired fertility, number of eggs, embryonic development, hatching percentage and survival of chickens.
- Genetic and developmental problems: problems of locomotion, partial albinism and melanism or promotion of tumors.

In the light of current knowledge there is enough evidence of serious effects from this technology to wildlife. For this reason precautionary measures should be developed, alongside environmental impact assessments prior to installation, and a ban on installation of phone masts in protected natural areas and in places where endangered species are present. Surveys should take place to objectively assess the severity of effects.

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References

[1] J.M.R. Delgado, Biological effects of extremely low frequency electromagnetic fields, J. Bioelectr. 4 (1985) 75–91.
[2] A. Firstenberg, Microwaving Our Planet: The Environmental Impact of the Wireless Revolution, 11210, Cellular Phone Taskforce, Brooklyn, NY, 1997.
[3] A.L. Galeev, The effects of microwave radiation from mobile telephones on humans and animals, Neurosci. Behav. Physiol. 30 (2000) 187–194.
[4] I. Belyaev, Non-thermal biological effects of microwaves, Microw. Rev. 11 (2005) 13–29, http://www.mwr.medianis.net/pdf/Vol11No2-03-IBelyaev.pdf.
[5] H.P. Hutter, H. Moshammer, P. Wallner, M. Kundi, Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations, Occup. Environ. Med. 63 (2006) 307–313.
[6] T. Haumann, U. Munzenberg, W. Maes, P. Sierck, HF-radiation levels of GSM cellular phone towers in residential areas, in: 2nd International Workshop on Biological effects of EMFS, Rhodes, Greece, 2002.
[7] W.R. Adey, Tissue interactions with non-ionizing electromagnetic fields, Physiol. Rev. 61 (1981) 435–514.
[8] G.J. Hyland, Physics and biology of mobile telephony, Lancet 356 (2000) 1–8.
[9] H. Lai, Biological effects of radiofrequency electromagnetic field, in: Encyclopaedia of Biomaterials and Biomedical Engineering, 2005, doi:10.1081/E-EBBE-120041846, pp. 1–8.
[10] S. Kemerov, M. Marinkev, D. Getova, Effects of low-intensity electromagnetic fields on behavioral activity of rats, Folia Med. 41 (1999) 75–80.
[11] N. Nikolaevich, A. Igorevna, and G. Vasil, Influence of high-frequency electromagnetic radiation at non-thermal intensities on the human body (A review of work by Russian and Ukrainian researchers), No place to hide, 3 (Supplement), 2001.
[12] W.R. Adey, Bioeffects of mobile communications fields: possible mechanisms for cumulative dose. in: N. Kuster, Q. Balzano, J.C. Lin, (Eds.), Mobile communications safety, New York: Chapman & Hall, 1997, pp. 95–131.
[13] A. Úbeda, M.A. Trillo, L. Chacón, M.J. Blanco, J. Leal, Chick embryo development can be irreversibly altered by early exposure to weak extremely-low-frequency magnetic fields, Bioelectromagnetics 15 (1994) 385–398.
[14] I.U.G. Grigoriev, Role of modulation in biological effects of electromagnetic radiation, Radiats. Biol. Radioecol. 36 (1996) 659–670.
[15] G.J. Hyland, The physiological and environmental effects of non-ionising electromagnetic radiation, Working document for the STOA Panel, European Parliament, Directorate General for Research, 2001.
[16] R. Santini, J.M. Santini, P. danze, M. Leruz, M. Seigne, Enquête sur la santé de riverains de stations relais: I. Incidences de la distance et du sexe, Pathol. Biol. 50 (2002) 369–373.
[17] R. Santini, P. Santini, J.M. Le Ruz, M. Danze, M. Seigne, Survey study of people living in the vicinity of cellular phone base stations, Electromagn. Biol. Med. 22 (2003) 41–49.
[18] R. Santini, P. Santini, J.M. Danze, P. Le Ruz, M. Seigne, Symptoms experienced by people in vicinity of base stations: II/Incidences of age, duration of exposure, location of subjects in relation to the antennas and other electromagnetic factors, Pathol. Biol. 51 (2003) 412–415.
[19] E.A. Navarro, J. Segura, M. Portolés, C. Gómez Perretta, The microwave syndrome: a preliminary study in Spain, Electromagn. Biol. Med. 22 (2003) 161–169.
[20] G. Oberfeld, E. Navarro, M. Portoles, C. Maestu, C. Gomez-Perretta, The microwave syndrome—further aspects of a Spanish study, in: EBEA Congres Kos, Greece, 2004.
[21] G. Abdel-Rassoul, M.A. Salem, A. Michael, F. Farahat, M. El-Batanouny, E. Salem, Neurobehavioral effects among inhabitants around mobile phone base stations, Neurotoxicology 28 (2007) 434–440.
[22] I.N. Magras, T.D. Xenos, Radiation-induced changes in the prenatal development of mice, Bioelectromagnetics 18 (1997) 455–461.
[23] A. Balmori, Possible effects of electromagnetic fields from phone masts on a population of white stork (*Ciconia ciconia*), Electromagn. Biol. Med. 24 (2005) 109–119.
[24] J. Everaert, D. Bauwens, A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding House Sparrows (*Passer domesticus*), Electromagn. Biol. Med. 26 (2007) 63–72.
[25] A. Balmori, Ö. Hallberg, The urban decline of the house sparrow (*Passer domesticus*): a possible link with electromagnetic radiation, Electromagn. Biol. Med. 26 (2007) 141–151.
[26] M.J. Raven, D.G. Noble, S.R. Baillie, The breeding bird survey (2002), BTO Research Report 334, British Trust for Ornithology, Thetford, 2003.
[27] J.D. Summers-Smith, The decline of the house sparrow: a review, Brit. Birds 96 (2003) 439–446.
[28] J. De Laet, Ligue Royale Belgue pour la Protection des Oiseaux avec l'Université de Gand, 2004, <http://www.protectiondesoiseaux.be/content/view/801/74/> (Accessed on May 20, 2008).
[29] A. Prowse, The urban decline of the house sparrow, Brit. Birds 95 (2002) 143–146.
[30] A. Balmori, Aves y telefonía móvil. Resultados preliminares de los efectos de las ondas electromagnéticas sobre la fauna urbana, El ecologista 36 (2003) 40–42.
[31] C.K. Chou, A.W. Guy, L.L. Kunz, R.B. Johnson, J.J. Crowley, J.H. Krupp, Long-term, low-level microwave irradiation of rats, Bioelectromagnetics 13 (1992) 469–496.
[32] E.T. Novoselova, E.E. Fesenko, Stimulation of production of tumour necrosis factor by murine macrophages when exposed in vivo and in vitro to weak electromagnetic waves in the centimeter range, Biofizika 43 (1998) 1132–1133.
[33] K.J. Fernie, D.M. Bird, Evidence of oxidative stress in American kestrels exposed to electromagnetic fields, Environ. Res. A 86 (2001) 198–207.
[34] R.C. Beasond, P. Semm, Responses of neurons to an amplitude modulated microwave stimulus, Neurosci. Lett. 33 (2002) 175–178.
[35] K.J. Fernie, D.M. Bird, R.D. Dawson, P.C. Lague, Effects of electromagnetic fields on the reproductive success of American kestrels, Physiol. Biochem. Zool. 73 (2000) 60–65.
[36] K.J. Fernie, N.J. Leonard, D.M. Bird, Behavior of free-ranging and captive American kestrels under electromagnetic fields, J. Toxicol. Environ. Health, Part A 59 (2000) 597–603.
[37] K.J. Fernie, S.J. Reynolds, The effects of electromagnetic fields from power lines on avian reproductive biology and physiology: a review., J. Toxicol. Environ. Health, Part B 8 (2005) 127–140.
[38] K.J. Fernie, D.M. Bird, Effects of electromagnetic fields on body mass and food-intake of American kestrels, Condor 101 (1999) 616–621.
[39] S. Dasdag, M.A. Ketani, Z. Akdag, A.R. Ersay, I. Sar, Ö.C. Demirtas, M.S. Celik, Whole body microwave exposure emitted by cellular phones and testicular function of rats, Urol. Res. 27 (1999) 219–223.
[40] M. Davoudi, C. Brössner, W. Kuber, Der Einfluss elektromagnetischer wellen auf die Spermienmotilität, J. für Urol. Urogynäkol. 9 (2002) 18–22.
[41] I. Fejes, Z. Za Vaczki, J. Szollosi, R.S. Kolosza, J. Daru, L. Kova Cs, L.A. Pa, Is there a relationship between cell phone use and semen quality? Arch. Androl. 51 (2005) 385–393.
[42] P. Stefanis, A. Drakeley, R. Gazvani, D.I. Lewis-Jones, Growing concern over the safety of using mobile phones and male fertility, Arch. Androl. 52 (2006) 9–14.

Please cite this article in press as: A. Balmori, Electromagnetic pollution from phone masts. Effects on wildlife, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.01.007

[43] O. Erogul, E. Oztas, I. Yildirim, T. Kir, E. Aydur, G. Komesli, H.C. Irkilata, M.K. Irmak, A.F. Peker, Effects of electromagnetic radiation from a cellular phone on human sperm motility: an in vitro study, Arch. Med. Res. 37 (2006) 840–843.

[44] A. Agarwal, F. Deepinder, R.K. Sharma, G. Ranga, J. Li, Effect of cell phone usage on semen analysis in men attending infertility clinic: an observational study, Fertil. Steril. 89 (2008) 124–128.

[45] A. Wdowiak, L. Wdowiak, H. Wiktor, Evaluation of the effect of using mobile phones on male fertility, Ann. Agric. Environ. Med. 14 (1) (2007) 169–172.

[46] J.G. Yan, A.M. Gresti, T. Bruce, Y.H. Yan, A. Granlund, H.S. Matloub, Effects of cellular phone emissions on sperm motility in rats, Fertil. Steril. 88 (4) (2007) 957–964.

[47] P.F. Doherty, T.C. Grubb, Effects of high-voltage power lines on birds breeding within the powerlines' electromagnetic fields, Sialia 18 (1996) 129–134.

[48] V. Garaj-Vrhovac, D. Horvat, Z. Koren, The relationship between colony-forming ability, chromosome aberrations and incidence of micronuclei in V79 Chinese hamster cells exposed to microwave radiation, Mutat. Res. 263 (1991) 143–149.

[49] H. Lai, N.P. Singh, Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells, Bioelectromagnetics 16 (1995) 207–210.

[50] S. Balode, Assessment of radio-frequency electromagnetic radiation by the micronucleus test in bovine peripheral erythrocytes, Sci. Total Environ. 180 (1996) 81–85.

[51] I. Belyaev, L. Hillert, E. Markova, R. Sarimov, L. Malmgren, B. Persson, M. Harms-Ringdahl, Microwaves of mobile phones affect human lymphocytes from normal and hypersensitive subjects dependent on frequency, in: 26th Annual Meeting of the Bioelectromagnetics (BEMS), Washington, USA, 2004.

[52] G. Demsia, D. Vlastos, D.P. Matthopoulos, Effect of 910-MHz electromagnetic field on rat bone marrow, Sci. World J. 4 (2004) 48–54.

[53] Reflex, 2004, <http://www.verum-foundation.de/cgi-bin/content.cgi?id=euprojekte01>.

[54] E. Diem, C. Schwarz, F. Adlkofer, O. Jahn, H. Rudiger, Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro, Mut. Res. 583 (2005) 178–183.

[55] A.G. Gandhi, P. Singh, Cytogenetic damage in mobile phone users: preliminary data, Int. J. Hum. Genet. 5 (2005) 259–265.

[56] A. Di Carlo, N. Wite, F. Guo, P. Garrett, T. Litovitz, Chronic electromagnetic field exposure decreases HSP70 levels and lowers cytoprotection, J. Cell. Biochem. 84 (2002) 447–454.

[57] D. Leszczynski, S. Joenväärä, J. Reivinen, R. Kuokka, Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: molecular mechanism for cancer- and blood-brain barrier-related effects, Differentiation 70 (2002) 120–129.

[58] E. Berman, L. Chacon, D. House, B.A. Koch, W.E. Koch, J. Leal, S. Lovtrup, E. Mantiply, A.H. Martin, G.I. Martucci, K.H. Mild, J.C. Monahan, M. Sandstrom, K. Shamsaifar, R. Tell, M.A. Trillo, A. Ubeda, P. Wagner, Development of chicken embryos in a pulsed magnetic field, Bioelectromagnetics 11 (1990) 169–187.

[59] B.J. Youbicier-Simo, M. Bastide, Pathological effects induced by embryonic and postnatal exposure to EMFs radiation by cellular mobile phones, Radiat. Protect. 1 (1999) 218–223.

[60] A. Úbeda, J. Leal, M.A. Trillo, M.A. Jimenez, J.M.R. Delgado, Pulse shape of magnetic fields influences chick embryogenesis, J. Anat. 137 (1983) 513–536.

[61] J.M. Farrel, T.L. Litovitz, M. Penafiel, The effect of pulsed and sinusoidal magnetic fields on the morphology of developing chick embryos, Bioelectromagnetics 18 (1997) 431–438.

[62] Ju.G. Grigoriew, Influence of the electromagnetic field of the mobile phones on chickens embryo, to the evaluation of the dangerousness after the criterion of this mortality, J. Radiat. Biol. 5 (2003) 541–544.

[63] F. Batellier, I. Couty, D. Picard, J.P. Brillard, Effects of exposing chicken eggs to a cell phone in "call" position over the entire incubation period, Theriogenology 69 (2008) 737–745.

[64] L. Veterány, A. Veterányová, J. Jedlicka, Effect of magnetic field on embryonic mortality, Cesk. Fysiol. 50 (2001) 141–143.

[65] K.B. Hotary, K.R. Robinson, Evidence of a role for endogenous electrical fields in chick embryo development, Development 114 (1992) 985–996.

[66] M. Mevissen, M. Haübler, Acceleration of mammary tumorigenesis by exposure of 7,12-dimethylbenz(a)anthracene-treated female rats in a 50-Hz, 100-μT magnetic field: replication study, J. Toxicol. Environ. Health, Part A 53 (1998) 401–418.

[67] D. Flipo, M. Fournier, C. Benquet, P. Roux, C. Le Boulaire, Increased apoptosis, changes in intracellular Ca^{2+}, and functional alterations in lymphocytes and macrophages after in vitro exposure to static magnetic field, J. Toxicol. Environ. Health, Part A 54 (1998) 63–76.

[68] M. Fedrowitz, K. Kamino, W. Löscher, Significant differences in the effects of magnetic field exposure on 7,12 dimethylbenz (a)anthracene-induced mammary carcinogenesis in two sub-strains of Sprague-Dawley rats, Cancer Res. 64 (2004) 243–251.

[69] A.H. Frey, S.R. Feld, Avoidance by rats of illumination with low power nonionizing electromagnetic energy, J. Comp. Physiol. Psychol. 89 (1975) 183–188.

[70] M.A. Navakatikian, L.A. Tomashevskaya, Phasic behavioral and endocrine effects of microwaves of nonthermal intensity, in: D.O. Carpenter (Ed.), Biological Effects of Electric and Magnetic Fields, 1, Academic Press, San Diego, CA, 1994.

[71] D.D. Krstić, B.J. Đinđić, D.T. Sokolović, V.V. Marković, D.M. Petković, S.B. Radić, The results of experimental exposition of mice by mobile telephones, in: TELSIKS Conference, Serbia and Montenegro, Microw. Rev. (2005) 34–37.

[72] I.U.G. Grigoriev, S.N. Luk'ianova, V.P. Makarov, V.V. Rynskov, N.V. Moiseeva, Motor activity off rabbits in conditions of chronic low-intensity pulse microwave irradiation, Radiat. Biol. Radioecol. 35 (1995) 29–35.

[73] B. Nicholls, P.A. Racey, Bats avoid radar installations: Could electromagnetic fields deter bats from colliding with wind turbines? PLOS One 3 (2007) e297.

[74] A. Balmori Murciélago rabudo–*Tadarida teniotis*, En: Enciclopedia Virtual de los Vertebrados Españoles, Carrascal, L.M., Salvador, A. (Eds.), Museo Nacional de Ciencias Naturales, Madrid, 2004c, <http://www.vertebradosibericos.org/>.

[75] T.A. Marks, C.C. Ratke, W.O. English, Strain voltage and developmental, reproductive and other toxicology problems in dogs, cats and cows: a discussion, Vet. Human Toxicol. 37 (1995) 163–172.

[76] W. Löscher, G. Käs, Conspicuous behavioural abnormalities in a dairy cow herd near a TV and radio transmitting antenna, Pract. Vet. Surg. 29 (1998) 437–444.

[77] A. Yurekli, M. Ozkan, T. Kalkan, H. Saybasili, H. Tuncel, P. Atukeren, K. Gumustas, S. Seker, GSM Base Station Electromagnetic Radiation and Oxidative Stress in Rats, Electromagn. Biol. Med. 25 (2006) 177–188.

[78] S. Tofani, G. Agnesod, P. Ossola, S. Ferrini, R. Bussi, Effects of continuous low-level exposure to radio-frequency radiation on intrauterine development in rats, Health Phys. 51 (1986) 489–499.

[79] T.P. Moorhouse, D.W. Macdonald, Indirect negative impacts of radio-collaring: sex ratio variation in water voles, J. Appl. Ecol. 42 (2005) 91.

[80] R.F. McGivern, R.Z. Sokol, W.R. Adey, Prenatal exposure to a low-frequency electromagnetic field demasculinizes adult scent marking behavior and increases accessory sex organ weights in rats, Teratology 41 (1990) 1–8.

[81] G.M. Lee, R.R. Neutra, L. Hristova, M. Yost, R.A. Hiatt, A Nested Case-Control Study of Residential and Personal Magnetic Field Measures and Miscarriages, Epidemiology 13 (2002) 21–31.

Please cite this article in press as: A. Balmori, Electromagnetic pollution from phone masts. Effects on wildlife, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.01.007

[82] A.Y. Rezk, K. Abdulqawi, R.M. Mustafa, T.M. Abo El-Azm, H. Al-Inany, Fetal and neonatal responses following maternal exposure to mobile phones, Saudi Med. J. 29 (2008) 218–223.
[83] L.G. Salford, A.E. Brun, J.L. Eberhardt, L. Malmgren, B.R. Persson, Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones, Environ. Health Perspect. 111 (2003) 881–893.
[84] D. Adang, B. Campo, A.V. Vorst, Has a 970 MHz Pulsed exposure an effect on the memory related behaviour of rats? in: The 9th European Conference onWireless Technology, September 2006, 2006, pp.
[85] A.A. Kolodynski, V.V. Kolodynska, Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia, Sci. Total Environ. 180 (1996) 87–93.
[86] H.A. Divan, L. Kheifets, C. Obel, J. Olsen, Prenatal and postnatal exposure to cell phone use and behavioral problems in children, Epidemiology 19 (2008) 523–529.
[87] K. Mann, J. Roschkle, Effects of pulsed high-frequency electromagnetic fields on human sleep, Neuropsychobiology 33 (1996) 41–47.
[88] A.V. Kramarenko, U. Tan, Effects of high-frequency electromagnetic fields on human EEG: a brain mapping study, Int. J. Neurosci. 113 (2003) 1007–1019.
[89] A.A. Marino, E. Nilsen, C. Frilot, Nonlinear changes in brain electrical activity due to cell phone radiation, Bioelectromagnetics 24 (2003) 339–346.
[90] A.R. Blaustein, P.T.J. Johnson, Explaining frog deformities, Sci. Am. 288 (2003) 60–65.
[91] A. Balmori, The incidence of electromagnetic pollution on the amphibian decline: is this an important piece of the puzzle? Toxicol. Environ. Chem. 88 (2006) 287–299.
[92] W.C. Levengood, A new teratogenic agent applied to amphibian embryos, J. Embryol. Exp. Morphol. 21 (1969) 23–31.
[93] R.H. Landesman, W. Scott Douglas, Abnormal limb regeneration in adult newts exposed to a pulsed electromagnetic field, Teratology 42 (1990) 137–145.
[94] N.M. Grefner, T.L. Yakovleva, I.K. Boreysha, Effects of electromagnetic radiation on tadpole development in the common frog (*Rana temporaria* L.), Russ. J. Ecol. 29 (1998) 133–134.
[95] A. Balmori, in preparation: Phone masts effects on common frog (*Rana temporaria*) tadpoles: An experiment in the city. See the video clips in: http://www.hese-project.org/hese-uk/en/issues/nature.php?id=frogs.
[96] U. Warnke, Bienen, vögel und menschen, Die Zerstörung der Natur durch "Elektrosmog". Kompetenzinitiative, 2007 46 pp.
[97] R.L. Carpenter, E.M. Livstone, Evidence for nonthermal effects of microwave radiation: Abnormal development of irradiated insect pupae, IEEE Trans. Microw. Theor. Tech. 19 (1971) 173–178.
[98] D. Weisbrot, H. Lin, L. Ye, M. Blank, R. Goodman, Effects of mobile phone radiation on reproduction and development in *Drosophila melanogaster*, J. Cell. Biochem. 89 (2003) 48–55.
[99] D.J. Panagopoulos, A. Karabarbounis, L.H. Margaritis, Effect of GSM 900 MHz Mobile Phone Radiation on the Reproductive Capacity of *Drosophila melanogaster*, Electromagn. Biol. Med. 23 (2004) 29–43.
[100] D.J. Panagopoulos, E.D. Chavdoula, A. Karabarbournis, L.H. Margaritis, Comparison of bioactivity between GSM 900 MHz and DCS 1800 MHz mobile telephony radiation, Electromagn. Biol. Med. 26 (2007) 33–44.
[101] A. Balmori, Efectos de las radiaciones electromagnéticas de la telefonía móvil sobre los insectos, Ecosistemas (2006).
[102] H. Stever, J. Kuhn, C.Otten, B.Wunder, W. Harst, Verhaltensanderung unter elektromagnetischer Exposition. Pilotstudie, Institut für mathematik. Arbeitsgruppe, Bildungsinformatik. Universität Koblenz-Landau, 2005.
[103] V.G. Balodis, K. Brumelis, O. Kalviskis, D. Nikodemus, V.Z. y Tjarve, Does the Skrunda radio location station diminish the radial growth of pine trees? Sci. Total Environ. 180 (1996) 57–64.
[104] T. Selga, M. Selga, Response of *Pinus Sylvestris* L. needles to electromagnetic fields. Cytological and ultraestructural aspects, Sci. Total Environ. 180 (1996) 65–73.
[105] I. Magone, The effect of electromagnetic radiation from the Skrunda Radio Location Station on Spirodela polyrhiza (L.) Schleiden cultures, Sci. Total Environ. 180 (1996) 75–80.
[106] D.D. Sandu, C. Goiceanu, A. Ispas, I. Creanga, S. Miclaus, D.E. Creanga, A preliminary study on ultra high frequency electromagnetic fields effect on black locust chlorophylls, Acta Biol. Hung. 56 (2005) 109–117.
[107] D. Roux, Al. Vian, S. Girard, P. Bonnet, F. Paladian, E. Davies, G. Ledoigt, High frequency (900 MHz) low amplitude (5 V m^{-1}) electromagnetic field: a genuine environmental stimulus that affects transcription, translation, calcium and energy charge in tomato, Planta 227 (2007) 883–891.
[108] M. Tkalec, K. Malarik, B. Pevalek-Kozlina, Exposure to radiofrequency radiation induces oxidative stress in duckweed *Lemna minor* L., Sci. Total Environ. 388 (2007) 78–89.
[109] A. Balmori, ¿Pueden afectar las microondas pulsadas emitidas por las antenas de telefonía a los árboles y otros vegetales? Ecosistemas (2004), http://www.revistaecosistemas.net/articulo.asp?Id=29&Id_Categoria=1&tipo=otros_contenidos.
[110] V. Schorpp, 2007, <http://www.puls-schlag.org/baumschaeden.htm#linden>.
[111] A. Balmori, Posibles efectos de las ondas electromagnéticas utilizadas en la telefonía inalámbrica sobre los seres vivos, Ardeola 51 (2004) 477–490.

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FM-radio and TV tower signals can cause spontaneous hand movements near moving RF reflector

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Abstract

For testing human sensitivity to radio frequency (RF) standing waves a movable reflecting wall was constructed. Radio waves from the radio–TV tower reflected back and formed a standing wave near the reflector. When the reflector was moved, the position of the maximums of the standing waves changed and the electromagnetic intensity changed in the body of the standing test subject. The computer with an AD-converter registered the signals of the hand movement transducer and the RF-meter with 100 MHz dipole antennas. A total of 29 adults of different ages were tested. There were 9 persons whose hand movement graphs included features like the RF-meter. Six showed responses that did not correlate with the RF-meter. There were also 14 persons who did not react at all. Sensitive persons seem to react to crossing standing waves of the FM-radio or TV broadcasting signals.

Keywords: Sensorimotor responses; Radio frequency standing waves

1. Introduction

Radio frequency radiation (RFR) has been studied intensively in the near GHz region. Subjective symptoms, sleeping problems and cognitive performance have been reported in subjects living near mobile phone base stations [1]. In the recent past, frequencies of FM-radio and television (TV) signals have been much less studied even though these frequencies cause biological and health effects, too. The whole body resonance frequency of an average man and thus the maximum absorption of RF energy occur at 70–80 MHz [2]. This is near the frequencies used in very high frequency (VHF) broadcasting. The head and limbs absorb much more energy than the torso at frequencies above body resonance [3]. Greatest absorption in the head region of man occurs at a frequency of about 375 MHz [4]. Absorption is stronger for wave propagation from head to toe than it is when the electric field is parallel to the long axis. The authors [4] believed that the enchanced absorption in the head region may make head resonance significant in the study of behavioral effects, blood–brain barrier permeability, cataractogenesis, and other microwave bioeffects. Even increased health risks like cancer, especially melanoma incidence, near FM broadcasting and television transmitters have been reported [5,6].

Nerve impulses initiate muscle contraction by calcium ion release from the sarcoplasmic reticulum, which takes place when electric nerve signals reach the plasma membrane and T-tubules of muscle fibers [7]. Voltage dependent Ca-channels open. Acetylcholine esterase (AChE) breaks down the acetylcholine, and Na-channels close [7]. It has been reported that the number of Ca^{2+} ions liberated from hen's frontal brain depends on the modulation frequency of the weak VHF radiation, with a maximum at a frequency of 16 Hz, while an unmodulated field causes no ion release [2,8]. Multiple RF power-density windows in calcium ion release from brain tissue have presented [9]. A significant decrease in AChE activity has been found in rats exposed to radio frequency radiation of 147 MHz and its sub-harmonics 73.5 and 36.75 MHz amplitude modulated at 16 and 76 Hz. A decrease in AChE activity was independent of carrier wave frequencies [10].

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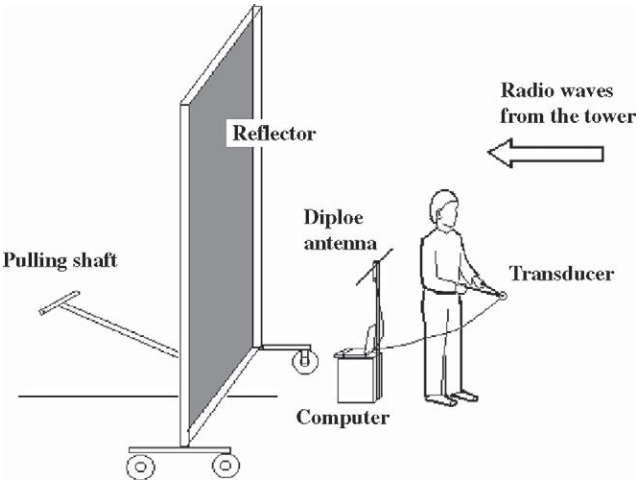

Fig. 1. Testing human radio wave sensitivity. Radio waves from the TV tower reflect back from the reflector and form a standing wave. When the reflector moves, the position of the maximums of the standing wave change, and the electromagnetic intensity changes in the body of the test subject. The computer with an AD-converter registers the signals of hand movement transducer and the RF-meter with the dipole antennas.

As there is previous evidence from human and animal studies that electromagnetic irradiation has effects in the brain, the aim of the present study was to find out, if the motor responses are generated in sensitive persons, when they move across a set of standing waves caused by radiation of a FM-radio and TV tower. The connection between the hand movements and the integrated intensity of electromagnetic field of FM-radio broadcasting were recorded.

2. Methods

The wavelength of a 100-MHz radio wave is 3 m. For testing human sensitivity to moving standing waves a movable reflecting wall with wooden frame 3 m height and 5 m wide was constructed (Fig. 1). Steel net of 20 mm × 20 mm mesh was used. Five horizontal net slices of 60 cm wide were bound together with steel wire forming a radio waves reflecting surface. The test place was 5 km from the FM-radio tower. The frame was placed in an open field perpendicular to the incoming wave. The test subject was standing back towards the frame, and he had the hand movement transducer in his hands. The RF-meter with horizontal dipole antenna was close behind him. When started, the frame was 2 m from his back and it was moved 20 m forth and back. The computer registered both signals. The method and the aim of the test were at first presented, in brief, to the test persons. All together 29 adult persons of different ages were tested. They were participants in a seminar relating to effects of electric fields, and thus they possibly do not represent a normal population.

The broadband (30–300 MHz) RF-meter and the hand movement transducer were constructed for this study by the authors. The signals were digitised by Pico high resolution data logger (ADC16). The radio frequency spectrum was measured using a spectrum analyser (GW instek GSP-827, 2.7 GHz) with 1.5 m horizontal dipole antennas. When measured, the antenna was fastened to a wooden frame 1 m from the ground.

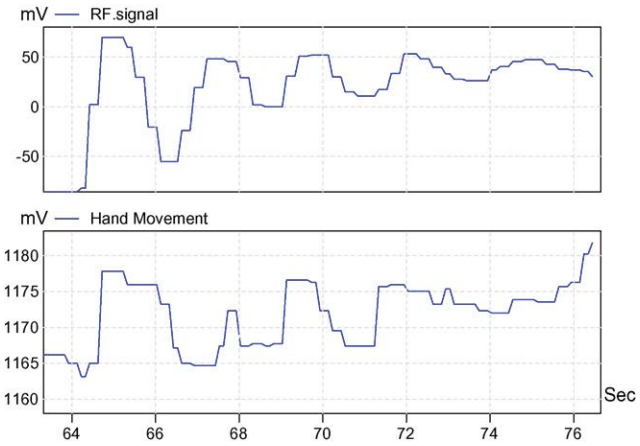

Fig. 2. Hand movements near the moving RF reflector. The standing waves moved slowly with the reflector. Intensity of the electric field was measured with the broadband RF-meter with horizontal dipole antennas. Variation of the field intensity is presented in the upper curve and the hand movements of the standing test person are in the lower curve.

3. Results and discussion

Results on the movable frame showed different hand movement reactions of the test subjects. There were 9 persons who reacted like the RF-meter (Fig. 2), 6 persons whose graphs, though obvious, showed no correlation to the RF-meter and 14 persons who did not react or showed only small noise like changes in their graphs (Table 1). Spectrum at the test place contains mainly the FM-radio broadcasting signals and four digital TV signals (Fig. 3). Most prominent (85 dB μV, approximately 50 mV/m) are the 6 horizontally polarized FM-radio signals (Fig. 4).

Resonances in body parts affects the power absorption. Theoretically, the optimal length of a thin antenna in radio-frequency reception is nearly half of the wavelength of the

Table 1
Reactions to standing waves of FM-radio signals. Classification of results of 29 tested persons. Test subject was standing and the radio wave reflector was moved behind him/her. The hand movement graphs were compared to the graphs of the broadband radio frequency (RF) meter.

Reactions to standing waves	9 persons	Hand movement graphs include features like graphs of RF-meter.
Possible reaction	6 persons	Changes in the graphs but no correlation to RF-meter.
No reaction	14 persons	Only small noise like changes in the graphs.

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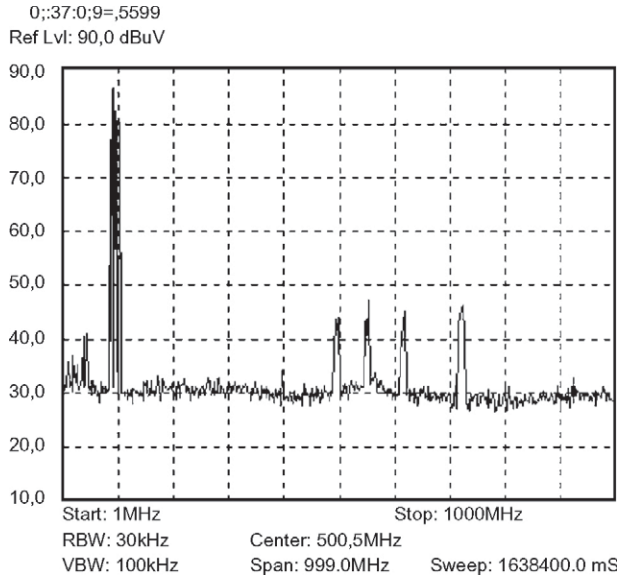

Fig. 3. Spectrum 1–1000 MHz at the test place. The highest peaks at the left are FM-radio broadcasting signals and the four lower peaks in the middle are the digital TV signals. Because the measurement was made with 1.5 m dipoles, signals near 100 MHz are more prominent because of antenna resonance.

incoming radio wave. The experimental maximum whole body resonance frequency is lower than the resonance frequency for an ideal half wave dipole antenna [11]. The whole body resonance length of a human at the frequencies of 80–108 MHz applied to FM broadcasting is about 1.1–1.5 m. Because in this experiment the test subjects were standing and the 100 MHz FM-radio signals and TV signals at higher frequencies are horizontally polarized, the absorption is obviously higher in the shoulder area. The distance between two maximums of the 100 MHz standing wave is 1.5 m. The half

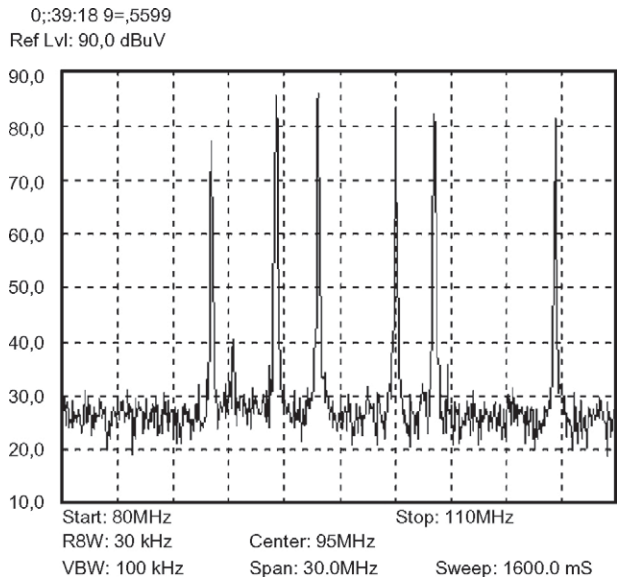

Fig. 4. Spectrum of the FM-radio broadcasting at the test place. Six channels were sending and the maximum electric field intensity was 85 dB μV.

waves of local digital TV signals (500–700 MHz) are only about 20–30 cm. This means that there can be many maximums of standing waves of TV signals in the body at the same time, even near the reflector.

The biggest variation in the local field intensity was caused by the FM broadcasting. There were 6 channels in the tower. Because of different wave lengths, the standing waves near the reflector are at the same phase and they amplify each other, but further away, the phases are mixed and so the amplitude of the summed standing waves is smaller.

With this experiment, we cannot exactly say where the reaction occurs, in limbs, muscles or in the head. It is possible that a change of intensity in standing radiowaves causes a small change in the nerve-muscle permeability of the nerve signal. The person feels it like a spontaneous muscle contraction. His hands are moving away and closer when the standing waves are passing. By some persons, the distance from hand to hand varied 0–60 cm. That means that some of muscles in arms and shoulders should react.

The spectrum contains many frequencies of electromagnetic radiation. The radiation is not only coming from the nearest tower, and it is impossible to clean the test area from other waves. This experiment was made at rural area, but even there, the private hand held telephone signals cause interferences to RF-instruments.

4. Conclusions

Sensitive persons seem to react to crossing standing waves of the FM-radio or TV broadcasting signals. The reactions were apparently initiated by RFR near reflecting objects, but they became more random in very weak variations of total field intensity. In any case, individuals are different, and in natural situations many sources interfere with each other.

References

[1] H.-P. Hutter, H. Moshammer, P. Wallner, M. Kundi, Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations, Occup. Environ. Med. 63 (2006) 307–313.
[2] R.V. Adey, Frequency and power windowing in tissue interactions with weak electromagnetic fields, Proc. IEEE 68 (1) (1980) 119–125.
[3] R.G. Olsen, T.A. Griner, Specific absorption rate in mondels of man and monkey at 225 and 2,000 MHz, Bioelectromagnetics 8 (1987) 377–384.
[4] M.J. Hagmann, O.P. Gandhi, J.A. D'andrea, I. Chatterjee, Head resonance: numerical solutions and experimental results, IEEE Trans. Microw. Theory Tech. MTT-27 (9) (1979) 809–813.
[5] H.G. Dolk, P. Shaddik, Walls, et al., Cancer incidence near radio and television transmitters in Great Britain I and II, Am.J. Epidemiol. 145 (1997) 1–17.
[6] Ö. Hallberg, O. Johansson, Melanoma incidence and frequency modulation (FM) broadcasting., Arch. Environ. Health 57 (1) (2002) 32–40.
[7] B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, J.D. Watson (Eds.), Moleclar Biology of the Cell, The Nervous System, Garland Publishing Inc., New York/London, 1983, pp. 1013–1098 (Chapter 18).

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[8] C.F. Blackman, J.A. Elder, C.M. Weil, S.G. Benane, D.C. Eichinger, D.E. House, Induction of calcium-ion efflux from brain tissue by radio-frequency radiation: effects of modulation frequency and field strength, Radio Sci. 14 (1979) 93–98.
[9] C. Blackman, L.S. Kinney, D.E. House, W.T. Joines, Multiple power-density windows and their possible origin, Bioelectromagnetics 10 (2) (1989) 115–128.
[10] K.K. Kunjilwar, J. Behari, Effects of amplitude-modulated radio frequency radiation on cholinergic system of developing rats, Brain Res. 601 (1–2) (1993) 321–324.
[11] O.P. Gandhi, State of the knowledge for electromagnetic absorbed dose in man and animals (1980), Proc. IEEE 68 (1980) 24–32.

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Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment☆

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Abstract

Many national and international exposure standards for maximum radiation exposure from the use of cell phone and other similar portable devices are ultimately based on the production of heat particularly in regions of the head, that is, thermal effects (TE). The recent elevation in some countries of the allowable exposure, that is, averaging the exposure that occurs in a 6 min period over 10 g of tissue rather than over 1 g allows for greater heating in small portions of the 10-g volume compared to the exposure that would be allowed averaged over 1-g volume. There is concern that 'hot' spots, that is, momentary higher intensities, could occur in portions of the 10-g tissue piece, might have adverse consequences, particularly in brain tissue.

There is another concern about exposure to cell phone radiation that has been virtually ignored except for the National Council of Radiation Protection and Measurements (NCRP) advice given in a publication in 1986 [National Council for Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields, National Council for Radiation Protection and Measurements, 1986, 400 pp.]. This NCRP review and guidance explicitly acknowledge the existence of non-thermal effects (NTE), and included provisions for reduced maximum-allowable limits should certain radiation characteristics occur during the exposure.

If we are to take most current national and international exposure standards as completely protective of thermal injury for acute exposure only (6 min time period) then the recent evidence from epidemiological studies associating increases in brain and head cancers with increased cell phone use per day and per year over 8–12 years, raises concerns about the possible health consequences on NTE first acknowledged in the NCRP 1986 report [National Council for Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields, National Council for Radiation Protection and Measurements, 1986, 400 pp.].

This paper will review some of the salient evidence that demonstrates the existence of NTE and the exposure complexities that must be considered and understood to provide appropriate, more thorough evaluation and guidance for future studies and for assessment of potential health consequences. Unfortunately, this paper is necessary because most national and international reviews of the research area since the 1986 report [National Council for Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields, National Council for Radiation Protection and Measurements, 1986, 400 pp.] have not included scientists with expertise in NTE, or given appropriate attention to their requests to include NTE in the establishment of public-health-based radiation exposure standards. Thus, those standards are limited because they are not comprehensive.

Keywords: Non-thermal effects; Electromagnetic fields; Exposure standards

1. Introduction

1.1. The current approach to exposure limits (based on heating and electric current flow in tissues)

It is universally accepted that radiofrequency radiation (RFR) can cause tissue heating (thermal effects, TE) and that extremely low-frequency (ELF) fields, e.g., 50

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and 60 Hz, can cause electrical current flows that shock and even damage or destroy tissues. These factors alone are the underlying bases for present exposure standards. EMF exposures that cause biological effects at intensities that do not cause obvious thermal changes, that is, non-thermal effects (NTE), have been widely reported in the scientific literature since the 1970s including beneficial applications in development and repair processes. The current public safety limits do not take modulation into account and thus are no longer sufficiently protective of public health where chronic exposure to pulsed or pulse-modulated signal is involved, and where sub-populations of more susceptible individuals may be at risk from such exposures.

1.2. Modulation as a critical element

Modulation signals are one important component in the delivery of EMF signals to which cells, tissues, organs and individuals can respond biologically. At the most basic level, modulation can be considered a pattern of pulses or repeating signals which have specific meaning in defining that signal apart from all others. Modulated signals have a specific 'beat' defined by how the signal varies periodically or aperiodically over time. Pulsed signals occur in an on–off pattern, which can be either smooth and rhythmic, or sharply pulsed in quick bursts. Amplitude and frequency modulation involves two very different processes where the high-frequency signal, called the carrier wave, has a lower frequency signal that is superimposed on or 'rides' on the carrier frequency. In amplitude modulation, the lower frequency signal is embedded on the carrier wave as changes in its amplitude as a function of time, whereas in frequency modulation, the lower frequency signal is embedded as slight changes in the frequency of the carrier wave. Each type of low-frequency modulation conveys specific 'information', and some modulation patterns are more effective (more bioactive) than others depending on the biological reactivity of the exposed material. This enhanced interaction can be a good thing for therapeutic purposes in medicine, but can be deleterious to health where such signals could stimulate disease-related processes, such as increased cell proliferation in precancerous lesions. Modulation signals may interfere with normal, non-linear biological functions. More recent studies of modulated RF signals report changes in human cognition, reaction time, brainwave activity, sleep disruption and immune function. These studies have tested the RF and ELF-modulated RF signals from emerging wireless technologies (cell phones) that rely on pulse-modulated RF to transmit signals. Thus modulation can be considered as information content embedded in the higher frequency carrier wave that may have biological consequences beyond any effect from the carrier wave directly.

In mobile telephony, for example, modulation is one of the underlying ways to categorize the radiofrequency signal of one telecom carrier from another (TDMA from CDMA from GSM). Modulation is likely a key factor in determining whether and when biological reactivity might be occurring, for example in the new technologies which make use of modulated signals, some modulation (the packaging for delivery for an EMF 'message') may be bioactive, for example, when frequencies are similar to those found in brain wave patterns. If a new technology happens to use brain wave frequencies, the chances are higher that it will have effects, in comparison, for example, to choosing some lower or higher modulation frequency to carry the same EMF information to its target.

This chapter will show that other EMF factors may also be involved in determining if a given low-frequency signal directly, or as a modulation of a radiofrequency wave, can be bioactive. Such is the evolving nature of information about modulation. It argues for great care in defining standards that are intended to be protective of public health and well-being. This chapter will also describe some features of exposure and physiological conditions that are required in general for non-thermal effects to be produced, and specifically *to illustrate how modulation is a fundamental factor which should be taken into account in public safety standards*.

2. Laboratory evidence

Published laboratory studies have provided evidence for more than 40 years on bioeffects at much lower intensities than cited in the various widely publicized guidelines for limits to prevent harmful effects. Many of these reports show EMF-caused changes in processes associated with cell growth control, differentiation and proliferation, that are biological processes of considerable interest to physicians for potential therapeutic applications and for scientists who study the molecular and cellular basis of cancer. EMF effects have been reported in gene induction, transmembrane signaling cascades, gap junction communication, immune system action, rates of cell transformation, breast cancer cell growth, regeneration of damaged nerves and recalcitrant bone-fracture healing. These reports have cell growth control as a common theme. Other more recent studies on brainwave activity, cognition and human reaction time lend credence to modulation (pulsed RF and ELF-modulated RF) as a concern for wireless technologies, most prominently from cell phone use.

In the process of studying non-thermal biological effects, various exposure parameters have been shown to influence whether or not a specific EMF can cause a biological effect, including intensity, frequency, the co-incidence of the static magnetic field (both the natural earth's magnetic field and anthropogenic fields), the presence of the electrical field, the magnetic field, or their combination, and whether EMF is sinusoidal, pulsed or in more com-

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plex wave forms. These parameters will be discussed below.

Experimental results will be used to illustrate the influence of each EMF parameter, while also demonstrating that it is highly unlikely the effects are due to EMF-caused current flow or heating.

2.1. Initial studies that drew attention to NTE

Several papers in the 1960s and early 1970s reported that ELF fields could alter circadian rhythms in laboratory animals and humans. In the latter 1960s, a paper by Hamer [2] reported that the EMF environment in planned space capsules could cause human response time changes, i.e., the interval between a signal and the human response. Subsequent experiments by a research group led by Adey were conducted with monkeys, and showed similar response time changes and also EEG pattern changes [3,4]. The investigators shifted the research subject to cats and decided they needed to use a radiofrequency field to carry the ELF signal into the cat brain, and observed EEG pattern changes, ability to sense and behaviorally respond to the ELF component of RFR, and the ability of minor electric current to stimulate the release of an inhibitory neurotransmitter, GABA, and simultaneous release of a surrogate measure, calcium ions, from the cortex [5,6]. At this time Bawin, a member of the research group, adopted newly hatch chickens as sources of brain tissue and observed changes in the release of calcium ions from in vitro specimens as a function of ELF frequency directly or as amplitude modulation ('am') of RFR (RFRam) [7–11]. Tests of both EMF frequency and intensity dependences demonstrated a single sensitive region (termed 'window') over the range of frequency and intensity examined. This series of papers showed that EMF-induced changes could occur in several species (human, monkey, cat and chicken), that calcium ions could be used as surrogate measures for a neurotransmitter, that ELF fields could produce effects similar to RFRam (note: without the 'am', there was no effect although the RFR intensity was the same), and that the dose and frequency response consisted of a single sensitivity window.

Subsequent, independent research groups published a series of papers replicating and extending this earlier work. Initial studies by Blackman, Joines and colleagues [12–25] used the same chick brain assay system as Bawin and colleagues. These papers reported multiple windows in intensity and in frequency within which calcium changes were observed in the chick brain experimental systems under EMF exposure. Three other independent groups offered confirmation of these results by reporting intensity and frequency windows for calcium, neurotransmitter or enolase release under EMF exposure of human and animal nervous system-derived cells in vitro by Dutta et al. [26–29], of rat pancreatic tissue slices by Albert et al. [30], and of frog heart by Schwartz et al. [31] but not frog-heart atrial strips in vitro [32]. This series of papers showed that multiple frequency and intensity windows were a common phenomenon that required the development of new theoretical concepts to provide a mechanism of action paradigm.

2.2. Refined laboratory studies reveal more details

Additional aspects of the EMF experiments with the chick brain described by Blackman and colleagues, above, also revealed critical co-factors that influenced the action of EMF to cause changes in calcium release, including the influence of the local static magnetic field, and the influence of physico-chemical parameters, such as pH, temperature and the ionic strength of the bathing solution surrounding the brain tissue during exposure. This information provides clues for and constraints on any theoretical mechanism that is to be developed to explain the phenomenon. Most current theories ignore these parameters that need to be monitored and controlled for EMF exposure to produce NTE. These factors demonstrate that the current risk assessment paradigms, which ignore them, are incomplete and thus may not provide the level of protection currently assumed.

2.3. Sensitivity of developing organisms

An additional study was also conducted to determine if EMF exposure of chicken eggs while the embryo was developing could influence the response of brain tissue from the newly hatched chickens. The detailed set of frequency and intensity combinations under which effects were observed, were all obtained from hatched chickens whose eggs were incubated for 21 days in an electrically heated chamber containing 60-Hz fields. Thus tests were performed to determine if the 60-Hz frequency of ELF fields (10 V/m in air) during incubation, i.e., during embryogenesis and organogenesis, would alter the subsequent calcium release responses of the brain tissue to EMF exposure. The reports of Blackman et al. [19] and Joines et al. [25] showed that the brain tissue response was changed when the field during the incubation period was 50 Hz rather than 60 Hz. This result is consistent with an anecdotal report of adult humans, institutionalized because of chemical sensitivities, who were also responsive to the frequency of power-line EM fields that were present in the countries where they were born and raised [33]. This information indicates there may be animal and human exposure situations where EMF imprinting during development could be an important factor in laboratory and epidemiological situations. EMF imprinting, which may only become manifest when a human is subjected to chemical or biological stresses, could reduce ability to fight disease and toxic insult from environmental pollution, resulting in a population in need of more medical services, with resulting lost days at work.

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3. Fundamental exposure parameters—to be considered when establishing a mode (or mechanism) of action for non-thermal EMF-induced biological effects

3.1. Intensity

There are numerous reports of biological effects that show intensity "windows", that is, regions of intensity that cause changes surrounded by higher and lower intensities that show no effects from exposure. One very clear effect by Blackman and colleagues is 16-Hz, sine wave-induced changes in calcium efflux from brain tissue in a test tube because it shows two very distinct and clearly separated intensity windows of effects surrounded by regions of intensities that caused no effects [17]. There are other reports for similar multiple windows of intensity in the radiofrequency range [22,26,29,31]. Note that calcium ions are a secondary signal transduction agent active in many cellular pathways. These results show that intensity windows exist, they display an unusual and unanticipated "non-linear" (non-linear and non-monotonic) phenomenon that has been ignored in all risk assessment and standard setting exercises, save the NCRP 1986 publication [1]. Protection from multiple intensity windows has never been incorporated into any risk assessment; to do so would call for a major change in thinking. These results mean that lower intensity is not necessarily less bioactive, or less harmful.

Multiple intensity windows appeared as an unexpected phenomenon in the late 1970s and 1980s. There has been one limited attempt to specifically model this phenomenon by Thompson et al. [34], which was reasonably successful. This modeling effort should be extended because there are publications from two independent research groups showing multiple intensity windows for 50, 147, and 450 MHz fields when amplitude modulated at 16 Hz using the calcium ion release endpoint in chicken brains, in vitro. The incident intensities (measured in air) for the windows at the different carrier frequencies do not align at the same values. However, Joines et al. [23,24] and Blackman et al. [20] noted the windows of intensity align across different carrier frequencies if one converts the incident intensity to the intensity expected within the sample at the brain surface. This conversion was accomplished by correcting for the different dielectric constants of the sample materials due to the different carrier frequencies. The uniqueness of this response provides a substantial clue to theoreticians but it is interesting and disappointing that no publications have appeared attempting to address this relationship. It is obvious that this phenomenon is one that needs further study.

3.2. Frequency

Frequency-dependent phenomena are common occurrences in nature. For example, the human ear only hears a portion of the sound that is in the environment, typically from 20 to 20,000 Hz, which is a frequency "window". Another biological frequency window can be observed for plants grown indoors. Given normal indoor lighting the plants may grow to produce lush vegetation but not produce flowers unless illuminated with a lamp that emits a different spectrum of light partially mimicking the light from the sun. Thus, frequency windows of response to various agents exist in biological systems from plants to homo sapiens.

In a similar manner, there are examples of EMF-caused biological effects that occur in a frequency-dependent manner that cannot be explained by current flow or heating. The examples include reports of calcium ion efflux from brain tissue in vitro by Blackman and Joines and colleagues at low frequency [15,19] and at high frequency modulated at low frequency [20,35,24]. An additional example of an unexpected result is by Liboff [36].

In addition, two apparently contradictory multiple-frequency exposure results provide examples of the unique and varied non-thermal interactions of EMF with biological systems. Litovitz and colleagues showed that an ELF sinusoidal signal could induce a biological response in a cell culture preparation, and that the addition of a noise signal of equal average intensity could block the effect caused by the sinusoidal signal, thereby negating the influence of the sinusoidal signal [37]. Similar noise canceling effects were observed using chick embryo preparations [38,39]. It was also shown that the biological effects caused by microwave exposures imitating cell phone signals could be mitigated by ELF noise [40]. However, this observation should not be generalized; a noise signal is not always benign. Milham and Morgan [41] showed that a sinusoidal ELF (60-Hz) signal was not associated with the induction of cancer in humans, but when that sinusoidal signal was augmented by a noise signal, basically transients that added higher frequencies, an increase in cancer was noted in humans exposed over the long-term. Thus, the addition of noise in this case was associated with the appearance of a health issue. Havas [42–44] has described other potential health problems associated with these higher frequency transients, termed "dirty power." The bioactive frequency regions observed in these studies have never been explicitly considered for use in any EMF risk assessments, thus demonstrating the incomplete nature of current exposure guideline limits.

There are also EMF frequency-dependent alterations in the action of nerve growth factor (NGF) to stimulate neurite outgrowth (growth of primitive axons or dendrites) from a peripheral-nerve-derived cell (PC-12) in culture shown by Blackman et al. [45,46] and by Trillo et al. [47]. The combined effect of frequency and intensity is also a common occurrence in both the analogous sound and the light examples given above. Too much or too little of either frequency or intensity show either no or undesirable effects. Similarly, Blackman et al. [15] has reported EMF responses composed of effect "islands" of intensity and frequency combinations, surrounded by a "sea" of intensity and frequency combinations of null effects. Although the mechanisms responsible

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for these effects have not been established, the effects represent a here-to-fore unknown phenomenon that may have complex ramifications for risk assessment and standard setting. Nerve growth and neurotransmitter release that can be altered by different combinations of EMF frequencies and intensities, especially in developing organisms like children, could conceivably produce over time a subsequent altered ability to successfully or fully respond behaviorally to natural stressors in the adult environment; research is urgently needed to test this possibility in animal systems.

Nevertheless, this phenomenon of frequency dependence is ignored in the development of present exposure standards. These standards rely primarily on biological responses to intensities within an arbitrarily defined engineering-based frequency bands, not biologically based response bands, and are solely based on an energy deposition determinations.

4. Static magnetic field—a completely unexpected complexity

The magnetic field of the earth at any given location has a relatively constant intensity as a function of time. However, the intensity value, and the inclination of the field with respect to the gravity vector, varies considerable over the face of the earth. More locally, these features of the earth's magnetic field can also vary by more than 20% inside manufactured structures, particularly those with steel support structures.

At the Bioelectromagnetics Society annual meeting in 1984 [48], Blackman revealed his group's discovery that the intensity of the static magnetic field could establish and define those oscillatory frequencies that would cause changes in calcium ion release in his chick brain preparation. This result was further discussed at a NATO Advanced Research workshop in Erice, Italy in the fall of 1984 and by publications from that meeting and subsequent research: Blackman et al. [14,18] and Liboff et al. [36,49,50]. Substantial additional research on this feature was reported by Liboff and colleagues [51,52,50]. Blackman et al. also reported on the importance of the relative orientation of the static magnetic field vector to the oscillating magnetic field vector [21] and demonstrated a reverse biological response could occur depending on parallel or perpendicular orientations of the static and oscillating magnetic fields [53].

There have been many attempts to explain this phenomenon by a number of research teams led by Smith [49], Blackman [15], Liboff [36,54], Lednev [55], Blanchard [56], Zhadin [57], del Giudice [58], Binhi [59–62], and Matronchik [63] but none has been universally accepted. Nevertheless, experimental results continued to report static and oscillating field dependencies for non-thermally induced biological effects in studies led by Zhadin [64,65], Vorobyov [66], Baureus Koch [67], Sarimov [68], Prato [69,70], Comisso [71], and Novikov [72].

With this accumulation of reports from independent, international researchers, it is now clear that if a biological response depends on the static magnetic field intensity, and even its orientation with respect to an oscillating field, then the conditions necessary to reproduce the phenomenon are very specific and might easily escape detection (see for example, Blackman and Most [73]. The consequences of these results are that there may be exposure situations that are truly detrimental (or beneficial) to organisms, but that are insufficiently common on a large scale that they would not be observed in epidemiological studies; they need to be studied under controlled laboratory conditions to determine impact on health and wellbeing.

5. Electric and magnetic components—both biological active with different consequences

Both the electric and the magnetic components have been shown to directly and independently cause biological changes. There is one report that clearly distinguishes the distinct biological responses caused by the electric field and by the magnetic field. Marron et al. [74] show that electric field exposure can increase the negative surface charge density of an amoeba, Physarum polycephalum, and that magnetic field exposure of the same organism causes changes in the surface of the organism to reduce its hydrophobic character. Other scientists have used concentric growth surfaces of different radii and vertical magnetic fields perpendicular to the growth surface to determine if the magnetic or the induced electric component is the agent causing biological change. Liburdy et al. [75], examining calcium influx in lymphocytes, and Greene et al. [76], monitoring ornithine decarboxylase (ODC) activity in cell culture, showed that the induced electric component was responsible for their results. In contrast, Blackman et al. [77,78] monitoring neurite outgrowth from two different clones of PC-12 cells and using the same exposure technique used by Liburdy and by Greene showed the magnetic component was the critical agent in their experiments. EMF-induced changes on the cell surface, where it interacts with its environment, can dramatically alter the homeostatic mechanisms in tissues, whereas changes in ODC activity are associated with the induction of cell proliferation, a desirable outcome if one is concerned about wound healing, but undesirable if the concern is tumor cell growth. This information demonstrates the multiple, different ways that EMF can affect biological systems. Present analyses for risk assessment and standard setting have ignored this information, thus making their conclusions of limited value.

6. Sine and pulsed waves—like different programs on a radio broadcast station

Important characteristics of pulsed waves that have been reported to influence biological processes include the following: (1) frequency, (2) pulse width, (3) intensity, (4) rise and fall time, and (5) the frequency, if any, within the pulse ON

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time. Chiabrera et al. [79] showed that pulsed fields caused de-differentiation of amphibian red blood cells. Scarfi et al. [80] showed enhanced micronuclei formation in lymphocytes of patients with Turner's syndrome (only one X chromosome) but no change in micronuclei formation when the lymphocytes were exposed to sine waves (Scarfi et al. [81]). Takahashi et al. [82] monitored thymidine incorporation in Chinese hamster cells and explored the influence of pulse frequency (two windows of enhancement reported), pulse width (one window of enhancement reported) and intensity (two windows of enhancement reported followed by a reduction in incorporation). Ubeda et al. [83] showed the influence of difference rise and fall times of pulsed waves on chick embryo development.

6.1. Importance for risk assessment

It is important to note that the frequency spectrum of pulsed waves can be represented by a sum of sine waves which, to borrow a chemical analogy, would represent a mixture of chemicals, anyone of which could be biologically active. Risk assessment and exposure limits have been established for specific chemicals or chemical classes of compounds that have been shown to cause undesirable biological effects. Risk assessors and the general public are sophisticated enough to recognize that it is impossible to declare all chemicals safe or hazardous; consider the difference between food and poisons, both of which are chemicals. A similar situation occurs for EMF; it is critical to determine which combinations of EMF conditions have the potential to cause biological harm and which do not.

Obviously, pulse wave exposures represent an entire genre of exposure conditions, with additional difficulty for exact independent replication of exposures, and thus of results, but with increased opportunities for the production of biological effects. Current standards were not developed with explicit knowledge of these additional consequences for biological responses.

7. Mechanisms

Two papers have the possibility of advancing understanding in this research area. Chiabrera et al. [84] created a theoretical model for EMF effects on an ion's interaction with protein that includes the influence of thermal energy and of metabolism. Before this publication, theoreticians assumed that biological effects in living systems could not occur if the electric signal is below the signal caused by thermal noise, in spite of experimental evidence to the contrary. In this paper, the authors show that this limitation is not absolute, and that different amounts of metabolic energy can influence the amount and parametric response of biological systems to EMF. The second paper, by Marino et al. [85], presents a new analytical approach to examine endpoints in systems exposed to EMF. The authors, focusing on exposure-induced lymphoid phenotypes, report that EMF may not cause changes in the mean values of endpoints, but by using recurrence analysis, they capture exposure-induced, statistically significant, non-linear movements of the endpoints to either side of the mean endpoint value. They provide further evidence using immunological endpoints from exposed and sham treated mice [86–88]. Additional research has emerged from this laboratory on EMF-induced animal and human brain activity changes that provides more evidence for the value of their research approach (Marino et al. [89–92], Kolomytkin et al. [93] and Carrubba et al. [94–98]). Further advanced theoretical and experimental studies of relevance to non-thermal biological effects are emerging; see for example reports by Binhi et al. [59–62], Zhadin et al. [64,99,65], and Novikov et al. [72]. *It is apparent that much remains to be examined and explained in EMF biological effects research through more creative methods of analysis than have been used before. The models described above need to be incorporated into risk assessment determinations.*

8. Problems with current risk assessments—observations of effects are segregated by artificial frequency bands that ignore modulation

One fundamental limitation of most reviews of EMF biological effects is that exposures are segregated by the physical (engineering/technical) concept of frequency bands favored by the engineering community. This is a default approach that follows the historical context established by the incremental addition of newer technologies that generate increasingly higher frequencies. However, this approach fails to consider unique responses from biological systems that are widely reported at various combinations of frequencies, modulations and intensities.

When common biological responses are observed without regard for the particular, engineering-defined EMF frequency band in which the effects occur, this reorganization of the results can highlight the commonalities in biological responses caused by exposures to EMF across the different engineering-defined frequency bands. An attempt to introduce this concept to escape the limitations of the engineering-defined structure occurred with the development of the 1986 NCRP radiofrequency exposure guidelines because published papers from the early 1970s to the mid 1980s (to be discussed below) demonstrated the need to include amplitude modulation as a factor in setting of maximum exposure limits. The 1986 NCRP guideline [1] was the one and only risk evaluation that included an exception for modulated fields.

The current research and risk assessment attempts are no longer tenable. The 3-year delay in the expected report of the 7-year Interphone study results has made this epidemiological approach a 10-year long effort, and the specific exposure conditions, due to improved technology, have changed so that the results may no longer be applicable to the current

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exposure situation. It is unproductive to continue to fund epidemiological studies of people who are exposed to a wide variety of diversified, uncontrolled, and poorly characterized EMF in their natural and work environments. In place of the funding of more epidemiological studies should be funding to support controlled laboratory studies to focus on the underlying processes responsible for the NTE described above, so that mechanisms or modes of action can be developed to provide a theoretical framework to further identify, characterize and unify the action of the heretofore ignored exposure parameters shown to be important.

8.1. Potential explanation for the failure to optimize research in EMF biological effects

Unfortunately, risk evaluations following the 1986 NCRP example [1], returned to the former engineering-defined analysis conditions, in part because scientists who reported non-thermal effects were not placed on the review committees, and in the terms of Slovic [100] "Risk assessment is inherently subjective and represent a blend of science and judgment with important psychological, social, cultural, and political factors. . . . Whoever controls the definition of risk controls the rational solution to the problem at hand. . . . Defining risk is thus an exercise in power." It appears that by excluding scientists experienced with producing non-thermal biological effects, the usually sound judgment by the selected committees was severely limited in its breadth-of-experience, thereby causing the members to retreat to their own limited areas of expertise when forced to make judgments, as described by Slovic [100], "Public views are also influenced by worldviews, ideologies, and values; so are scientists' views, particularly when they are working at limits of their expertise." The current practice of segregating scientific investigations (and resulting public health limits) by artificial divisions of frequency dramatically dilutes the impact of the basic science results, thereby reducing and distorting the weight of evidence in any evaluation process (see evaluations of bias by Havas [101], referring to NRC 1997 [102] compared to NIEHS 1998 [103] and NIEHS 1999 [104]).

9. Suggested research

Are there substitute approaches that would improve on the health-effects evaluation situation? As mentioned above, it may be useful in certain cases to develop a biologically based clustering of the data to focus on and enrich understanding of certain aspects of biological responses. Some examples to consider for biological clustering include: (1) EMF features, such as frequency and intensity inter-dependencies, (2) common co-factors, such as the earth's magnetic field or co-incident application of chemical agents to perturb and perhaps sensitize the biological system to EMF, or (3) physiological state of the biological specimen, such as age or sensitive sub-populations, including genetic predisposition as described by Fedrowitz et al. [105,106], and for human populations, recently reported by Yang et al. [107].

To determine if this approach has merit, one could combine reports of biological effects found in the ELF (including sub-ELF) band with effects found in the RF band when the RF exposures are amplitude modulated (AM) using frequencies in the ELF band. The following data should be used: (a) human response time changes under ELF exposure [2], (b) monkey response time and EEG changes under ELF exposure [3,4], (c) cat brain EEG, GABA and calcium ion changes induced by ELF and AM-RF [8,9,7,10,6,11,108,5], (d) calcium ion changes in chick brain tissue under ELF and AM-RF [8,9,7,10,13–15,21,16–18,12,19,20,22,35,23–25,11], and (e) calcium changes under AM-RF in brain cells in culture [26–28] and in frog heart under AM-RF [31]. The potential usefulness of applying biological clustering in the example given above even though AM is used, is that the results may have relevance to assist in the examination of some of the effects reportedly caused by cellular phone exposures which include more complex types of modulation of RF. This suggestion is reasonable because three groups later reported human responses to cell phone emissions that include changes in reaction times – Preece et al. [109,110], Koivisto et al. [111,112] and Krause et al. [113,114] – or to brain wave potentials that may be associated with reaction time changes—Freude et al. [115,116].

Subsequently, Preece et al. [117] tested cognitive function in children and found a trend, but not a statistically significant change in simple reaction time under exposure, perhaps because he applied a Bonferroni correction to his data (alpha for significance was required to be less than 0.0023). It would appear that a change in the experimental protocol might provide a more definitive test of the influence of exposure on simple reaction time because it is known that a Bonferroni correction is a particularly severe test of statistical significance, or as the author observed, "a particularly conservative criterion."

Krause et al. [118] examined cognitive activity by observing oscillatory EEG activity in children exposed to cell phone radiation while performing an auditory memory task and reported exposure related changes in the ~4–8 Hz EEG frequencies during memory encoding, and changes in that range and also ~15 Hz during recognition. The investigators also examined cognitive processing, an auditory memory task or a visual working memory task, in adults exposed to CW or pulsed cell phone radiation on either the right or left side of the head, and reported modest changes in brain EEG activity in the ~4–8 Hz region, compared to CW exposure, but with caveats that no behavior changes were observed, and that the data were varying, unsystematic and inconsistent with previous reports (Krause et al. [119]). Haarala and colleagues conducted an extensive series of experiments, examining reaction time [120], short-term memory [121], short-term memory in children [122], and right versus left hemisphere exposure [123]. Although these studies did not

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support the positive effects from exposure reported by others, they provided possible explanations for the apparent lack of agreement.

Other research groups have also examined the effects of cell phone radiation on the central nervous system, including Borbely et al. [124], Huber et al. [125], Loughran et al. [126], and D'Costa et al. [127], who found changes in sleep EEG patterns and other measures during or after short-term exposures, while others, such as Fritzer et al. [128] exposed for longer time periods found no changes in sleep parameters, EEG power spectra, correlation dimension nor cognitive function. The work of Pritchard [129] served as the basis to examining correlation dimensions, which is opening a potentially fertile avenue for investigation. Although this approach provides more indepth information on ongoing processes and function, it has not yet been used to address potential consequences associated with long-term cell phone use.

The papers published in the 1960s through 1991, described in earlier sections of this paper, foreshadowed the more recent publications in 1999 through 2008 showing response time changes, or associated measures, in human subjects during exposure to cell phone-generated radiation. It is unfortunate that essentially none of the earlier studies was acknowledged in these recent reports on cognition, reaction time and other measures of central nervous system processes. Without guidance from this extensive earlier work, particularly those demonstrating the variety of exposure parameter spaces that must be controlled to produce repeatable experiments, the development of the mechanistic bases for non-thermal effects from EMF exposures will be substantially delayed. The omission of the recognition of the exposure conditions that affect the biological outcomes continues as recently as the National Academy of Science 2009 publication [130] of future directions for research, which emphasizes the modest perspective in the results from committee members working at the limits of expertise, as anticipated by Slovic [100].

Let us hope that subsequent national and international committees that consider future directions for EMF research include members who have performed and reported non-thermal effects, in order to provide a broader perspective to develop programs that will more expeditiously address potential health problems as well as to provide guidance to industry on prudent procedures to establish for their technologies.

At present, we are left with a recommendation voiced in 1989 by Abelson [131] in an editorial in Science Magazine that addressed electric power-specific EMF, but is applicable to higher frequency EMF as well, to "adopt a prudent avoidance strategy" by "adopting those which look to be 'prudent' investments given their cost and our current level of scientific understanding about possible risks."

10. Conclusions

There is substantial scientific evidence that some modulated fields (pulsed or repeated signals) are bioactive, which increases the likelihood that they could have health impacts with chronic exposure even at very low exposure levels. Modulation signals may interfere with normal, non-linear biological processes. Modulation is a fundamental factor that should be taken into account in new public safety standards; at present it is not even a contributing factor. To properly evaluate the biological and health impacts of exposure to modulated RFR (carrier waves), it is also essential to study the impact of the modulating signal (lower frequency fields or ELF-modulated RF). Current standards have ignored modulation as a factor in human health impacts, and thus are inadequate in the protection of the public in terms of chronic exposure to some forms of ELF-modulated RF signals. The current IEEE and ICNIRP standards are not sufficiently protective of public health with respect to chronic exposure to modulated fields (particularly new technologies that are pulse-modulated and heavily used in cellular telephony). The collective papers on modulation appear to be omitted from consideration in the recent WHO and IEEE science reviews. This body of research has been ignored by current standard setting bodies that rely only on traditional energy-based (thermal) concepts. More laboratory as opposed to epidemiological research is needed to determine which modulation factors, and combinations are bioactive and deleterious at low intensities, and are likely to result in disease-related processes and/or health risks; however this should not delay preventative actions supporting public health and wellness. If signals need to be modulated in the development of new wireless technologies, for example, it makes sense to use what existing scientific information is available to avoid the most obviously deleterious exposure parameters and select others that may be less likely to interfere with normal biological processes in life. The current membership on Risk Assessment committees needs to be made more inclusive, by adding scientists experienced with producing non-thermal biological effects. The current practice of segregating scientific investigations (and resulting public health limits) by artificial, engineering-based divisions of frequency needs to be changed because this approach dramatically dilutes the impact of the basic science results and eliminates consideration of modulation signals, thereby reducing and distorting the weight of evidence in any evaluation process.

References

[1] National Council for Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields, National Council for Radiation Protection and Measurements, 1986, 400 pp.

[2] J. Hamer, Effects of low level, low frequency electric fields on human reaction time, Communications in Behavioral Biology 2 (5 part A) (1968) 217–222.

[3] R.J. Gavalas, D.O. Walter, J. Hamer, W.R. Adey, Effect of low-level, low-frequency electric fields on eeg and behavior in macaca nemestrina, Brain Research 18 (3) (1970) 491–501.

Please cite this article in press as: C. Blackman, Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.02.001

[4] R. Gavalas-Medici, S.R. Day-Magdaleno, Extremely low frequency, weak electric fields affect schedule-controlled behaviour of monkeys, Nature 261 (5557) (1976) 256–259.
[5] L.K. Kaczmarek, W.R. Adey, The efflux of 45ca2+ and (3 h)gamma-aminobutyric acid from cate cerebral cortex, Brain Research 63 (1973) 331–342.
[6] L.K. Kaczmarek, W.R. Adey, Weak electric gradients change ionic and transmitter fluxes in cortex, Brain Research 66 (3) (1974) 537–540.
[7] S.M. Bawin, L.K. Kaczmarek, W.R. Adey, Effects of modulated vhf fields on the central nervous system, Annals of the New York Academy of Sciences 247 (1975) 74–81.
[8] S.M. Bawin, W.R. Adey, Sensitivity of calcium binding in cerebral tissue to weak environmental electric fields oscillating at low frequency, Proceedings of the National Academy of Sciences of the United States of America 73 (6) (1976) 1999–2003.
[9] S.M. Bawin, W.R. Adey, I.M. Sabbot, Ionic factors in release of 45ca2+ from chicken cerebral tissue by electromagnetic fields, Proceedings of the National Academy of Sciences of the United States of America 75 (12) (1978) 6314–6318.
[10] S.M. Bawin, A.R. Sheppard, W.R. Adey, Possible mechanism of weak electromagnetic field coupling in brain tissue, Bioelectrochemistry & Bioenergetics 5 (1978) 67–76.
[11] A.R. Sheppard, S.M. Bawin, W.R. Adey, Models of long-range order in cerebral macromolecules: effects of sub-elf and of modulated vhf and uhf fields, Radio Science 14 (6S) (1979) 141–145.
[12] C.F. Blackman, J.A. Elder, C.M. Weil, S.G. Benane, D.C. Eichinger, D.E. House, Induction of calcium ion efflux from brain tissue by radio-frequency radiation: effects of modulation-frequency and field strength, Radio Science 14 (6S) (1979) 93–98.
[13] C.F. Blackman, S.G. Benane, J.A. Elder, D.E. House, J.A. Lampe, J.M. Faulk, Induction of calcium-ion efflux from brain tissue by radiofrequency radiation: effect of sample number and modulation frequency on the power-density window, Bioelectromagnetics 1 (1) (1980) 35–43.
[14] C.F. Blackman, The biological influences of low-frequency sinusoidal electromagnetic signals alone and superimposed on rf carrier waves; in: A. Chiabrera, C. Nicolini, H.P. Schwan (Eds.), Interaction between Electromagnetic Fields and Cells, Erice, Italy, Plenum, New York, 1984, NATO ASI Series A97, pp. 521–535.
[15] C.F. Blackman, S.G. Benane, D.J. Elliott, D.E. House, M.M. Pollock, Influence of electromagnetic fields on the efflux of calcium ions from brain tissue in vitro: a three-model analysis consistent with the frequency response up to 510 hz, Bioelectromagnetics 9 (3) (1988) 215–227.
[16] C.F. Blackman, S.G. Benane, W.T. Joines, M.A. Hollis, D.E. House, Calcium-ion efflux from brain tissue: power-density versus internal field-intensity dependencies at 50-mhz rf radiation, Bioelectromagnetics 1 (3) (1980) 277–283.
[17] C.F. Blackman, S.G. Benane, L.S. Kinney, W.T. Joines, D.E. House, Effects of elf fields on calcium-ion efflux from brain tissue in vitro, Radiation Research 92 (3) (1982) 510–520.
[18] C.F. Blackman, S.G. Benane, J.R. Rabinowitz, D.E. House, W.T. Joines, A role for the magnetic field in the radiation-induced efflux of calcium ions from brain tissue in vitro, Bioelectromagnetics 6 (4) (1985) 327–337.
[19] C.F. Blackman, D.E. House, S.G. Benane, W.T. Joines, R.J. Spiegel, Effect of ambient levels of power-line-frequency electric fields on a developing vertebrate, Bioelectromagnetics 9 (2) (1988) 129–140.
[20] C.F. Blackman, W.T. Joines, J.A. Elder, Calcium-ion efflux in brain tissue by radiofrequency radiation;, in: K.H. Illinger (Ed.), Biological Effects of Nonionizing Radiation, vol. 157, American Chemical Society, Washington, DC, 1981, pp. 299–314.
[21] C.F. Blackman, S.G. Benane, D.E. House, D.J. Elliott, Importance of alignment between local dc magnetic field and an oscillating magnetic field in responses of brain tissue in vitro and in vivo, Bioelectromagnetics 11 (2) (1990) 159–167.
[22] C.F. Blackman, L.S. Kinney, D.E. House, W.T. Joines, Multiple power-density windows and their possible origin, Bioelectromagnetics 10 (2) (1989) 115–128.
[23] W.T. Joines, C.F. Blackman, Equalizing the electric field intensity within chick brain immersed in buffer solution at different carrier frequencies, Bioelectromagnetics 2 (4) (1981) 411–413.
[24] W.T. Joines, C.F. Blackman, M.A. Hollis, Broadening of the rf power-density window for calcium-ion efflux from brain tissue, IEEE Transactions on Bio-Medical Engineering 28 (8) (1981) 568–573.
[25] W.T. Joines, C.F. Blackman, R.J. Spiegel, Specific absorption rate in electrically coupled biological samples between metal plates, Bioelectromagnetics 7 (2) (1986) 163–176.
[26] S.K. Dutta, K. Das, B. Ghosh, C.F. Blackman, Dose dependence of acetylcholinesterase activity in neuroblastoma cells exposed to modulated radio-frequency electromagnetic radiation, Bioelectromagnetics 13 (4) (1992) 317–322.
[27] S.K. Dutta, B. Ghosh, C.F. Blackman, Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture, Bioelectromagnetics 10 (2) (1989) 197–202.
[28] S.K. Dutta, A. Subramoniam, B. Ghosh, R. Parshad, Microwave radiation-induced calcium ion efflux from human neuroblastoma cells in culture, Bioelectromagnetics 5 (1) (1984) 71–78.
[29] S.K. Dutta, M. Verma, C.F. Blackman, Frequency-dependent alterations in enolase activity in escherichia coli caused by exposure to electric and magnetic fields, Bioelectromagnetics 15 (5) (1994) 377–383.
[30] E. Albert, C. Blackman, F. Slaby, Calcium dependent secretory protein release and calcium efflux during rf irradiation of rat pancreatic tissue slices, in: A.J. Berteaud, B. Servantie (Eds.), Ondes Electromagnetiques et Biologie, URSI International Symposium on Electromagnetic Waves and Biology, June 30–July 4. Jouy-en-Josas, France, Centre National de la Recherche Scientifique, 2 rue Henry Dunant, 94320 Thiais, France: A.J. Berteaud, 1980, pp. 325–329.
[31] J.L. Schwartz, D.E. House, G.A. Mealing, Exposure of frog hearts to cw or amplitude-modulated vhf fields: selective efflux of calcium ions at 16 hz, Bioelectromagnetics 11 (4) (1990) 349–358.
[32] J.L. Schwartz, G.A. Mealing, Calcium-ion movement and contractility in atrial strips of frog heart are not affected by low-frequency-modulated, 1 ghz electromagnetic radiation, Bioelectromagnetics 14 (6) (1993) 521–533.
[33] C.F. Blackman, Can EMF exposure during development leave an imprint later in life? Electromagnetic Biology and Medicine 25 (4) (2006) 217–225.
[34] C.J. Thompson, Y.S. Yang, V. Anderson, A.W. Wood, A cooperative model for ca(++) efflux windowing from cell membranes exposed to electromagnetic radiation, Bioelectromagnetics 21 (6) (2000) 455–464.
[35] W.T. Joines, C.F. Blackman, Power density, field intensity, and carrier frequency determinants of rf-energy-induced calcium-ion efflux from brain tissue, Bioelectromagnetics 1 (3) (1980) 271–275.
[36] A.R. Liboff, Cyclotron resonance in membrane transport, in: A. Chiabrera, C. Nicolini, H.P. Schwan (Eds.), Interaction Between Electromagnetic Fields and Cells, Erice, Italy, Plenum, New York, 1984, NATO ASI Series A97, pp. 281–296.
[37] T.A. Litovitz, D. Krause, C.J. Montrose, J.M. Mullins, Temporally incoherent magnetic fields mitigate the response of biological systems to temporally coherent magnetic fields, Bioelectromagnetics 15 (5) (1994) 399–409.
[38] J.M. Farrell, M. Barber, D. Krause, T.A. Litovitz, The superposition of a temporally incoherent magnetic field inhibits 60 hz-induced changes in the odc activity of developing chick embryos, Bioelectromagnetics 19 (1) (1998) 53–56.
[39] T.A. Litovitz, C.J. Montrose, P. Doinov, K.M. Brown, M. Barber, Superimposing spatially coherent electromagnetic noise inhibits field-induced abnormalities in developing chick embryos, Bioelectromagnetics 15 (2) (1994) 105–113.

Please cite this article in press as: C. Blackman, Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.02.001

[40] T.A. Litovitz, L.M. Penafiel, J.M. Farrel, D. Krause, R. Meister, J.M. Mullins, Bioeffects induced by exposure to microwaves are mitigated by superposition of elf noise, Bioelectromagnetics 18 (6) (1997) 422–430.
[41] S. Milham, L.L. Morgan, A new electromagnetic exposure metric: high frequency voltage transients associated with increased cancer incidence in teachers in a california school, American Journal of Industrial Medicine 51 (8) (2008) 579–586.
[42] M. Havas, Electromagnetic hypersensitivity: biological effects of dirty electricity with emphasis on diabetes and multiple sclerosis, Electromagnetic Biology and Medicine 25 (4) (2006) 259–268.
[43] M. Havas, Dirty electricity elevates blood sugar among electrically sensitive diabetics and may explain brittle diabetes, Electromagnetic Biology and Medicine 27 (2) (2008) 135–146.
[44] M. Havas, A. Olstad, Power quality affects teacher wellbeing and student behavior in three Minnesota schools, The Science of the Total Environment 402 (2–3) (2008) 157–162.
[45] C.F. Blackman, S.G. Benane, D.E. House, Frequency-dependent interference by magnetic fields of nerve growth factor-induced neurite outgrowth in pc-12 cells, Bioelectromagnetics 16 (6) (1995) 387–395.
[46] C.F. Blackman, J.P. Blanchard, S.G. Benane, D.E. House, Experimental determination of hydrogen bandwidth for the ion parametric resonance model, Bioelectromagnetics 20 (1) (1999) 5–12.
[47] M.A. Trillo, A. Ubeda, J.P. Blanchard, D.E. House, C.F. Blackman, Magnetic fields at resonant conditions for the hydrogen ion affect neurite outgrowth in pc-12 cells: a test of the ion parametric resonance model, Bioelectromagnetics 17 (1) (1996) 10–20.
[48] L. Slesin, Highlights: Elf bioeffects studies at bems, Microwave News IV (7, Sept.) (1984) 2.
[49] S.D. Smith, B.R. McLeod, A.R. Liboff, K. Cooksey, Calcium cyclotron resonance and diatom mobility, Bioelectromagnetics 8 (3) (1987) 215–227.
[50] J.R. Thomas, J. Schrot, A.R. Liboff, Low-intensity magnetic fields alter operant behavior in rats, Bioelectromagnetics 7 (4) (1986) 349–357.
[51] A.R. Liboff, B.R. McLeod, Kinetics of channelized membrane ions in magnetic fields, Bioelectromagnetics 9 (1) (1988) 39–51.
[52] A.R. Liboff, W.C. Parkinson, Search for ion-cyclotron resonance in an na(+)-transport system, Bioelectromagnetics 12 (2) (1991) 77–83.
[53] C.F. Blackman, J.P. Blanchard, S.G. Benane, D.E. House, Effect of ac and dc magnetic field orientation on nerve cells, Biochemical and Biophysical Research Communications 220 (3) (1996) 807–811.
[54] A.R. Liboff, Electric-field ion cyclotron resonance, Bioelectromagnetics 18 (1) (1997) 85–87.
[55] V.V. Lednev, Possible mechanism for the influence of weak magnetic fields on biological systems, Bioelectromagnetics 12 (2) (1991) 71–75.
[56] J.P. Blanchard, C.F. Blackman, Clarification and application of an ion parametric resonance model for magnetic field interactions with biological systems, Bioelectromagnetics 15 (3) (1994) 217–238.
[57] M.N. Zhadin, E.E. Fesenko, Ionic cyclotron resonance in biomolecules, Biomedical Science 1 (3) (1990) 245–250.
[58] E. Del Giudice, M. Fleischmann, G. Preparata, G. Talpo, On the "Unreasonable" Effects of elf magnetic fields upon a system of ions, Bioelectromagnetics 23 (7) (2002) 522–530.
[59] V.N. Binhi, Stochastic dynamics of magnetosomes and a mechanism of biological orientation in the geomagnetic field, Bioelectromagnetics 27 (1) (2006) 58–63.
[60] V.N. Binhi, A few remarks on 'combined action of dc and ac magnetic fields on ion motion in a macromolecule', Bioelectromagnetics 28 (5) (2007) 409–412, discussion 412–404.
[61] V.N. Binhi, A.B. Rubin, Magnetobiology: the kt paradox and possible solutions, Electromagnetic Biology and Medicine 26 (1) (2007) 45–62.
[62] V.N. Binhi, A.V. Savin, Molecular gyroscopes and biological effects of weak extremely low-frequency magnetic fields, Physical Review 65 (5 Pt 1) (2002) 051912.
[63] A.Y. Matronchik, I.Y. Belyaev, Mechanism for combined action of microwaves and static magnetic field: slow non uniform rotation of charged nucleoid, Electromagnetic Biology and Medicine 27 (4) (2008) 340–354.
[64] M.N. Zhadin, Combined action of static and alternating magnetic fields on ion motion in a macromolecule: theoretical aspects, Bioelectromagnetics 19 (5) (1998) 279–292.
[65] M.N. Zhadin, V.V. Novikov, F.S. Barnes, N.F. Pergola, Combined action of static and alternating magnetic fields on ionic current in aqueous glutamic acid solution, Bioelectromagnetics 19 (1) (1998) 41–45.
[66] V.V. Vorobyov, E.A. Sosunov, N.I. Kukushkin, V.V. Lednev, Weak combined magnetic field affects basic and morphine-induced rat's eeg, Brain Research 781 (1–2) (1998) 182–187.
[67] C.L. Baureus Koch, M. Sommarin, B.R. Persson, L.G. Salford, J.L. Eberhardt, Interaction between weak low frequency magnetic fields and cell membranes, Bioelectromagnetics 24 (6) (2003) 395–402.
[68] R. Sarimov, E. Markova, F. Johansson, D. Jenssen, I. Belyaev, Exposure to elf magnetic field tuned to zn inhibits growth of cancer cells, Bioelectromagnetics 26 (8) (2005) 631–638.
[69] F.S. Prato, M. Kavaliers, J.J. Carson, Behavioural evidence that magnetic field effects in the land snail, cepaea nemoralis, might not depend on magnetite or induced electric currents, Bioelectromagnetics 17 (2) (1996) 123–130.
[70] F.S. Prato, M. Kavaliers, A.P. Cullen, A.W. Thomas, Light-dependent and -independent behavioral effects of extremely low frequency magnetic fields in a land snail are consistent with a parametric resonance mechanism, Bioelectromagnetics 18 (3) (1997) 284–291.
[71] N. Comisso, E. Del Giudice, A. De Ninno, M. Fleischmann, L. Giuliani, G. Mengoli, F. Merlo, G. Talpo, Dynamics of the ion cyclotron resonance effect on amino acids adsorbed at the interfaces, Bioelectromagnetics 27 (1) (2006) 16–25.
[72] V.V. Novikov, I.M. Sheiman, E.E. Fesenko, Effect of weak static and low-frequency alternating magnetic fields on the fission and regeneration of the planarian dugesia (girardia) tigrina, Bioelectromagnetics 29 (5) (2008) 387–393.
[73] C.F. Blackman, B. Most, A scheme for incorporating dc magnetic fields into epidemiological studies of EMF exposure, Bioelectromagnetics 14 (5) (1993) 413–431.
[74] M.T. Marron, E.M. Goodman, P.T. Sharpe, B. Greenebaum, Low frequency electric and magnetic fields have different effects on the cell surface, FEBS Letters 230 (1–2) (1988) 13–16.
[75] R.P. Liburdy, Calcium signaling in lymphocytes and elf fields. Evidence for an electric field metric and a site of interaction involving the calcium ion channel, FEBS Letters 301 (1) (1992) 53–59.
[76] J.J. Greene, W.J. Skowronski, J.M. Mullins, R.M. Nardone, M. Penafiel, R. Meister, Delineation of electric and magnetic field effects of extremely low frequency electromagnetic radiation on transcription, Biochemical and Biophysical Research Communications 174 (2) (1991) 742–749.
[77] C.F. Blackman, S.G. Benane, D.E. House, Evidence for direct effect of magnetic fields on neurite outgrowth, FASEB J 7 (9) (1993) 801–806.
[78] C.F. Blackman, S.G. Benane, D.E. House, M.M. Pollock, Action of 50 hz magnetic fields on neurite outgrowth in pheochromocytoma cells, Bioelectromagnetics 14 (3) (1993) 273–286.
[79] A. Chiabrera, M. Hinsenkamp, A.A. Pilla, J. Ryaby, D. Ponta, A. Belmont, F. Beltrame, M. Grattarola, C. Nicolini, Cytofluorometry of electromagnetically controlled cell dedifferentiation, The Journal of Histochemistry and Cytochemistry 27 (1) (1979) 375–381.
[80] M.R. Scarfi, F. Prisco, M.B. Lioi, O. Zeni, M. Della Noce, R. Di Pietro, C. Fanceschi, D. Iafusco, M. Motta, B. F., Cytogenetic effects induced by extremely low frequency pulsed magnetic fields in lymphocytes from Turner's syndrome subjects, Bioelectrochemistry & Bioenergetics 43 (1997) 221–226.
[81] M.R. Scarfi, M.B. Lioi, O. Zeni, G. Franceschetti, C. Franceschi, F. Bersani, Lack of chromosomal aberration and micronucleus induction

Please cite this article in press as: C. Blackman, Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.02.001

in human lymphocytes exposed to pulsed magnetic fields, Mutation Research 306 (2) (1994) 129–133.
[82] K. Takahashi, I. Kaneko, M. Date, E. Fukada, Effect of pulsing electromagnetic fields on DNA synthesis in mammalian cells in culture, Experientia 42 (2) (1986) 185–186.
[83] A. Ubeda, J. Leal, M.A. Trillo, M.A. Jimenez, J.M. Delgado, Pulse shape of magnetic fields influences chick embryogenesis, Journal of Anatomy 137 (Pt 3) (1983) 513–536.
[84] A. Chiabrera, B. Bianco, E. Moggia, J.J. Kaufman, Zeeman-stark modeling of the rf EMF interaction with ligand binding, Bioelectromagnetics 21 (4) (2000) 312–324.
[85] A.A. Marino, R.M. Wolcott, R. Chervenak, F. Jourd'Heuil, E. Nilsen, C. Frilot 2nd, Nonlinear response of the immune system to power-frequency magnetic fields, American Journal of Physiology 279 (3) (2000) R761–768.
[86] A.A. Marino, R.M. Wolcott, R. Chervenak, F. Jourd'heuil, E. Nilsen, C. Frilot 2nd, Nonlinear determinism in the immune system. In vivo influence of electromagnetic fields on different functions of murine lymphocyte subpopulations, Immunological Investigations 30 (4) (2001) 313–334.
[87] A.A. Marino, R.M. Wolcott, R. Chervenak, F. Jourd'heuil, E. Nilsen, C. Frilot 2nd, Nonlinear dynamical law governs magnetic field induced changes in lymphoid phenotype, Bioelectromagnetics 22 (8) (2001) 529–546.
[88] A.A. Marino, R.M. Wolcott, R. Chervenak, F. Jourd'heuil, E. Nilsen, C. Frilot 2nd, S.B. Pruett, Coincident nonlinear changes in the endocrine and immune systems due to low-frequency magnetic fields, Neuroimmunomodulation 9 (2) (2001) 65–77.
[89] A.A. Marino, E. Nilsen, A.L. Chesson Jr., C. Frilot, Effect of low-frequency magnetic fields on brain electrical activity in human subjects, Clinical Neurophysiology 115 (5) (2004) 1195–1201.
[90] A.A. Marino, E. Nilsen, C. Frilot, Localization of electroreceptive function in rabbits, Physiology & Behavior 79 (4–5) (2003) 803–810.
[91] A.A. Marino, E. Nilsen, C. Frilot, Nonlinear changes in brain electrical activity due to cell phone radiation, Bioelectromagnetics 24 (5) (2003) 339–346.
[92] A.A. Marino, E. Nilsen, C. Frilot, Consistent magnetic-field induced dynamical changes in rabbit brain activity detected by recurrence quantification analysis, Brain Research 964 (2) (2003) 317–326.
[93] O.V. Kolomytkin, S. Dunn, F.X. Hart, C. Frilot 2nd, D. Kolomytkin, A.A. Marino, Glycoproteins bound to ion channels mediate detection of electric fields: a proposed mechanism and supporting evidence, Bioelectromagnetics 28 (5) (2007) 379–385.
[94] S. Carrubba, C. Frilot, A. Chesson, A.A. Marino, Detection of nonlinear event-related potentials, Journal of Neuroscience Methods 157 (1) (2006) 39–47.
[95] S. Carrubba, C. Frilot, A.L. Chesson, A.A. Marino, Nonlinear eeg activation evoked by low-strength low-frequency magnetic fields, Neuroscience Letters 417 (2) (2007) 212–216.
[96] S. Carrubba, C. Frilot 2nd, A.L. Chesson Jr., A.A. Marino, Evidence of a nonlinear human magnetic sense, Neuroscience 144 (1) (2007) 356–367.
[97] S. Carrubba, C. Frilot, A.L. Chesson Jr., A.A. Marino, Method for detection of changes in the eeg induced by the presence of sensory stimuli, Journal of Neuroscience Methods 173 (1) (2008) 41–46.
[98] S. Carrubba, C. Frilot, A.L. Chesson Jr., C.L. Webber Jr., J.P. Zbilut, A.A. Marino, Magnetosensory evoked potentials: consistent nonlinear phenomena, Neuroscience Research 60 (1) (2008) 95–105.
[99] M.N. Zhadin, O.N. Deryugina, T.M. Pisachenko, Influence of combined dc and ac magnetic fields on rat behavior, Bioelectromagnetics 20 (6) (1999) 378–386.
[100] P. Slovic, Trust, emotion, sex, politics, and science: surveying the risk-assessment battlefield, Risk Analysis 19 (4) (1999) 689–701.
[101] M. Havas, Biological effects of non-ionizing electromagnetic energy: a critical review of the reports by the US national research council and the us national institute of environmental health sciences as they relate to the broad realm of EMF bioeffects, Environmental Reviews 8 (2000) 173–253.
[102] National Research Council (U.S.), Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems, National Academy Press, Washington, DC, 1997, 356 pp.
[103] National Institute of Environmental Health Science Working Group Report, Assessment of health effects from exposure to power-line frequencyelectric and magnetic fields, 1998, NIH Pub 98-3981, 508 pp.
[104] National Institute of Environmental Health Science, Report on health effects from exposure to power-line frequency electric and magnetic fields, NIH Pub No 99-4493, 1999, 67 pp.
[105] M. Fedrowitz, K. Kamino, W. Loscher, Significant differences in the effects of magnetic field exposure on 7, 12-dimethylbenz(a)anthracene-induced mammary carcinogenesis in two substrains of sprague-dawley rats, Cancer Research 64 (1) (2004) 243–251.
[106] M. Fedrowitz, W. Loscher, Power frequency magnetic fields increase cell proliferation in the mammary gland of female fischer 344 rats but not various other rat strains or substrains, Oncology 69 (6) (2005) 486–498.
[107] Y. Yang, X. Jin, C. Yan, Y. Tian, J. Tang, X. Shen, Case-only study of interactions between DNA repair genes (hmlh1, apex1, mgmt, xrcc1 and xpd) and low-frequency electromagnetic fields in childhood acute leukemia, Leukemia & Lymphoma 49 (12) (2008) 2344–2350.
[108] S.M. Bawin, R.J. Gavalas-Medici, W.R. Adey, Effects of modulated very high frequency fields on specific brain rhythms in cats, Brain Research 58 (2) (1973) 365–384.
[109] A.W. Preece, G. Iwi, A. Davies-Smith, K. Wesnes, S. Butler, E. Lim, A. Varey, Effect of a 915-mhz simulated mobile phone signal on cognitive function in man, International Journal of Radiation Biology 75 (4) (1999) 447–456.
[110] A.W. Preece, K.A. Wesnes, G.R. Iwi, The effect of a 50 hz magnetic field on cognitive function in humans, International Journal of Radiation Biology 74 (4) (1998) 463–470.
[111] M. Koivisto, C.M. Krause, A. Revonsuo, M. Laine, H. Hamalainen, The effects of electromagnetic field emitted by gsm phones on working memory, Neuroreport 11 (8) (2000) 1641–1643.
[112] M. Koivisto, A. Revonsuo, C. Krause, C. Haarala, L. Sillanmaki, M. Laine, H. Hamalainen, Effects of 902 mhz electromagnetic field emitted by cellular telephones on response times in humans, Neuroreport 11 (2) (2000) 413–415.
[113] C.M. Krause, L. Sillanmaki, M. Koivisto, A. Haggqvist, C. Saarela, A. Revonsuo, M. Laine, H. Hamalainen, Effects of electromagnetic field emitted by cellular phones on the eeg during a memory task, Neuroreport 11 (4) (2000) 761–764.
[114] C.M. Krause, L. Sillanmaki, M. Koivisto, A. Haggqvist, C. Saarela, A. Revonsuo, M. Laine, H. Hamalainen, Effects of electromagnetic fields emitted by cellular phones on the electroencephalogram during a visual working memory task, International Journal of Radiation Biology 76 (12) (2000) 1659–1667.
[115] G. Freude, P. Ullsperger, S. Eggert, I. Ruppe, Effects of microwaves emitted by cellular phones on human slow brain potentials, Bioelectromagnetics 19 (6) (1998) 384–387.
[116] G. Freude, P. Ullsperger, S. Eggert, I. Ruppe, Microwaves emitted by cellular telephones affect human slow brain potentials, European journal of Applied Physiology 81 (1–2) (2000) 18–27.
[117] A.W. Preece, S. Goodfellow, M.G. Wright, S.R. Butler, E.J. Dunn, Y. Johnson, T.C. Manktelow, K. Wesnes, Effect of 902 mhz mobile phone transmission on cognitive function in children, Bioelectromagnetics (Suppl. 7) (2005) S138–143.
[118] C.M. Krause, C.H. Bjornberg, M. Pesonen, A. Hulten, T. Liesivuori, M. Koivisto, A. Revonsuo, M. Laine, H. Hamalainen, Mobile phone effects on children's event-related oscillatory eeg during an auditory memory task, International Journal of Radiation Biology 82 (6) (2006) 443–450.

Please cite this article in press as: C. Blackman, Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.02.001

[119] C.M. Krause, M. Pesonen, C. Haarala Bjornberg, H. Hamalainen, Effects of pulsed and continuous wave 902 mhz mobile phone exposure on brain oscillatory activity during cognitive processing, Bioelectromagnetics 28 (4) (2007) 296–308.

[120] C. Haarala, L. Bjornberg, M. Ek, M. Laine, A. Revonsuo, M. Koivisto, H. Hamalainen, Effect of a 902 mhz electromagnetic field emitted by mobile phones on human cognitive function: a replication study, Bioelectromagnetics 24 (4) (2003) 283–288.

[121] C. Haarala, M. Ek, L. Bjornberg, M. Laine, A. Revonsuo, M. Koivisto, H. Hamalainen, 902 mhz mobile phone does not affect short term memory in humans, Bioelectromagnetics 25 (6) (2004) 452–456.

[122] C. Haarala, M. Bergman, M. Laine, A. Revonsuo, M. Koivisto, H. Hamalainen, Electromagnetic field emitted by 902 mhz mobile phones shows no effects on children's cognitive function, Bioelectromagnetics Suppl. 7 (2005) S144–150.

[123] C. Haarala, F. Takio, T. Rintee, M. Laine, M. Koivisto, A. Revonsuo, H. Hamalainen, Pulsed and continuous wave mobile phone exposure over left versus right hemisphere: effects on human cognitive function, Bioelectromagnetics 28 (4) (2007) 289–295.

[124] A.A. Borbely, R. Huber, T. Graf, B. Fuchs, E. Gallmann, P. Achermann, Pulsed high-frequency electromagnetic field affects human sleep and sleep electroencephalogram, Neuroscience Letters 275 (3) (1999) 207–210.

[125] R. Huber, J. Schuderer, T. Graf, K. Jutz, A.A. Borbely, N. Kuster, P. Achermann, Radio frequency electromagnetic field exposure in humans: estimation of sar distribution in the brain, effects on sleep and heart rate, Bioelectromagnetics 24 (4) (2003) 262–276.

[126] S.P. Loughran, A.W. Wood, J.M. Barton, R.J. Croft, B. Thompson, C. Stough, The effect of electromagnetic fields emitted by mobile phones on human sleep, Neuroreport 16 (17) (2005) 1973–1976.

[127] H. D'Costa, G. Truemann, L. Tang, U. Abdel-rahman, W. Abdel-rahman, K. Ong, I. Cosic, Human brain wave activity during exposure to radiofrequency field emissions from mobile phones, Australasian Physical & Engineering Sciences in Medicine 26 (2003) 162–167.

[128] G. Fritzer, R. Goder, L. Friege, J. Wachter, V. Hansen, D. Hinze-Selch, J.B. Aldenhoff, Effects of short- and long-term pulsed radiofrequency electromagnetic fields on night sleep and cognitive functions in healthy subjects, Bioelectromagnetics 28 (4) (2007) 316–325.

[129] W.S. Pritchard, D.W. Duke, Measuring chaos in the brain: a tutorial review of nonlinear dynamical eeg analysis, The International Journal of Neuroscience 67 (1–4) (1992) 31–80.

[130] National Academy of Science, Identification of Research Needs Relating to Potential Biological or Adverse Health Effects of Wireless Communication, Washington, DC, 2009, http//www.nap.edu/catalog/12036.html.

[131] P.H. Abelson, Effects of electric and magnetic fields, Science (New York, N.Y.) 245 (4915) (1989) 241.

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Apparent decreases in Swedish public health indicators after 1997—Are they due to improved diagnostics or to environmental factors?

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Abstract

The object of this work was to review recent trends in public health in Sweden. Data on different adverse health indicators were collected from official Swedish registries. We found that population health generally improved during the early 1990s but suddenly started to deteriorate from 1997 onwards. This quite dramatic change is not likely to be explained only by improved diagnostics but physical causes need immediately to be searched for. A connection with the increasing exposure of the population to GHz radiation from mobile phones, base stations and other communication technologies cannot be ruled out.

Keywords: Alzheimer's disease; Heart malformations; Lung cancer; Melanoma; Prostata carcinoma; Traffic accidents; Mobile phone speech time

1. Introduction

During the first half of the 1990s, the Swedish population appeared increasingly healthy. Sick leave registrations decreased; in addition, lung cancer among older men steadily decreased and the incidence of prostate cancer levelled out, becoming stable or slightly decreasing between 1993 and 1997. In Stockholm, even the number of traffic accidents with injuries went down each year from 1985 to 1996. Mortality due to Alzheimer's disease increased in the early 1980s, but remained steady at 2.5–4 per 100,000 person-years (age standardized) from 1990 to 1997.

Objective of the present study: After 1997, public health appeared to decline markedly. Was this decrease the result of improvements in detection and diagnosis, or did maladies actually increase? In this paper, we take a look at several health trends, one by one, and analyze the suggested causes underlying the adverse health- and traffic safety indicators.

2. Materials and methods

All data were retrieved from the official databases of the National Health and Welfare Board (Socialstyrelsen; SoS) and of the Swedish Road Administration (Vägverket; VV). Hallberg and Johansson (2004) have presented worrying trends related to public health in Sweden [1]. Hallberg (2007) showed that many adverse health indicators were worse in sparsely populated areas, as hypothesized caused by higher average output power from mobile phones in those areas [2].

3. Results and discussion

1. Lung cancer among elderly men increased markedly beginning after 1997 (Fig. 1). For men aged 80–84 years, the incidence increased from 160 to 230/100,000. For men aged 85+, the incidence increased from 95 to a high of 180/100,000 in 2005. The SoS has not publicly offered any explanation for these increases or commented on this matter.
2. In 1997, the incidence of prostate cancer abruptly increased in all age groups (Fig. 2). In Stockholm, the number of cases in men aged 50–59 stayed fairly stable

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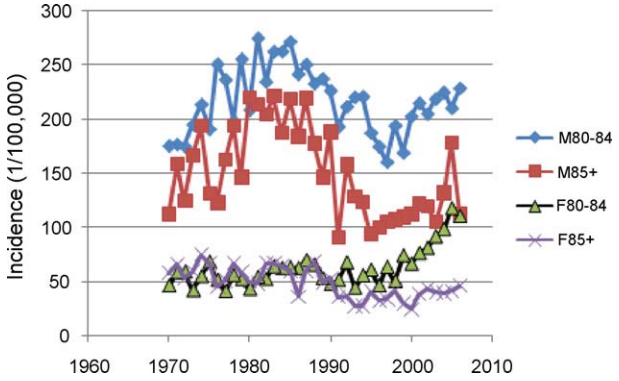

Fig. 1. Lung cancer in the elderly (male (M) and female (F)) has increased in Sweden since 1997.

at around 30 cases per year up to 1996, despite the fact that PSA tests were used routinely starting in 1991. After 1996, when 33 cases of prostate cancer were reported, the number of cases increased to around 300 per year in 2004 and 2005. SoS originally suggested that the apparent increase in prostate cancer was due to the improved diagnostic capabilities of the PSA test. When asked again, the SoS said, "It cannot, however, be ruled out that a certain increase would have been noticed even without these PSA tests, but we don't know how large this increase would have been." Notably, however, the step-like increase in prostate cancer did not coincide with the introduction of the PSA test in 1991.

3. For several decades, the rate of skin melanoma was very stable among younger people (<50 years), despite publicity about the dangers of sun exposure. However, after 2000 the incidence of melanoma of the head and neck region suddenly started to increase in this population (Fig. 3). Simultaneously, the rate of more benign skin tumours dropped, and the sum total of tumours and melanoma continued to increase. However, small carcinomas that would previously have developed into relatively benign tumours now seem to increasingly develop into melanoma. SoS has not commented on this in their reports.

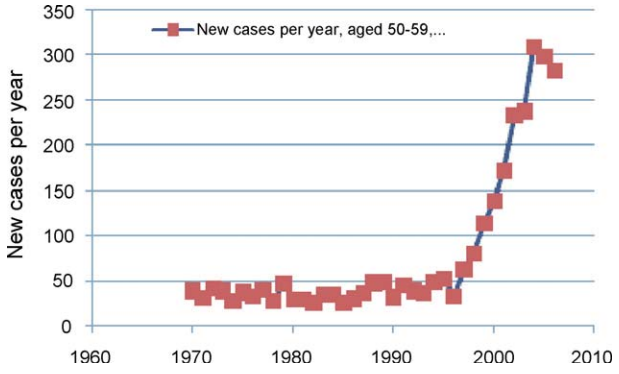

Fig. 2. The number of newly reported cases of prostate cancer in men aged 50–59 years in Stockholm County, Sweden.

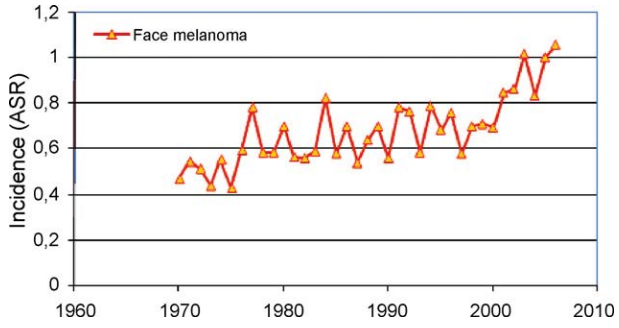

Fig. 3. Melanoma of the face has increased in Sweden among people <60 years since 2000.

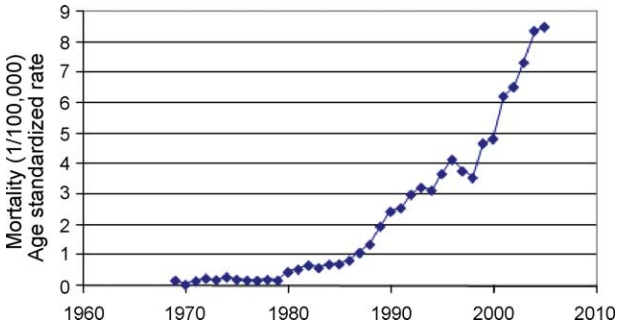

Fig. 4. Alzheimer's mortality has increased steeply since 1998 in Sweden.

4. Mortality associated with Alzheimer's disease has increased dramatically since 1998 (Fig. 4). Today, the incidence is 9/100,000, an increase of 300% in 10 years. When queried, the SoS suggested that this increase can be attributed to an increase in the practice of declaring Alzheimer's disease as the cause of death when signing the death certificate. SoS also claims that there are no grounds for stating that mortality has actually increased. However, a thorough analysis of the data indicates that there is an increase in mortality in older people with this disease [3].
5. In 1985, the number of people seriously injured in Stockholm traffic accidents was around 650. Subsequently, there was a decrease in injuries to a low of 350 in 1997. After 1997, the number of people injured annually started

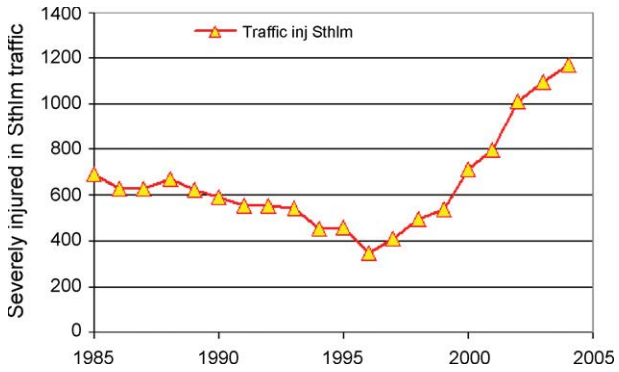

Fig. 5. Traffic injuries in Stockholm have increased since 1997.

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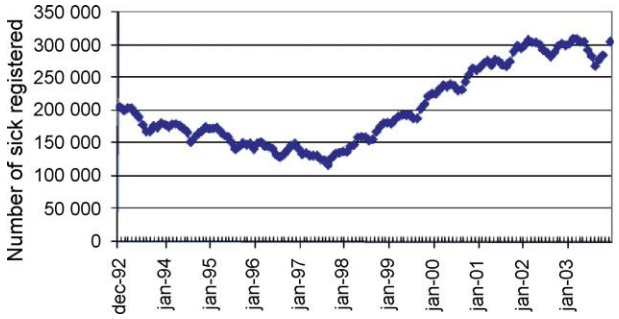

Fig. 6. The number of people in Sweden registered as sick suddenly increased starting in September 1997.

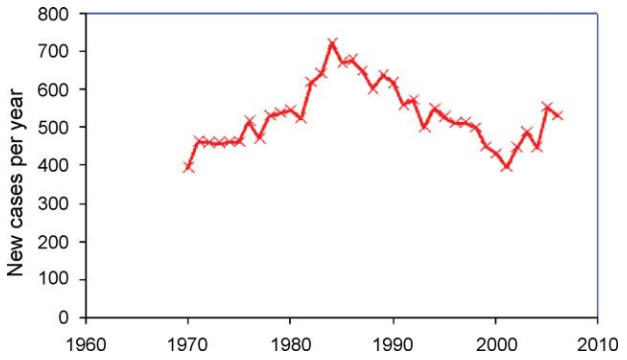

Fig. 7. Brain tumours among in the elderly (>60 years) have increased since 2001 in Sweden.

increasing, reaching 1200 in 2005 (Fig. 5). According to VV, this trend is partly the result of the introduction of a better reporting system in Stockholm. Nonetheless, the increasing number of people severely injured in Swedish traffic ended the downward trend observed until 1997: This number has rapidly increased since 2000. Today, VV reports that the number of people who were severely injured per killed increased rapidly in Stockholm County in the time period 2000–2004.

6. The total number of people taking sick leave was just over 200,000 in 1992. This number decreased steadily to around 125,000 in September 1997. After that time, the trend broke, and we saw an increase to over 300,000 people registering as sick in 2003 (Fig. 6). The authorities have not given any explanation for this abrupt increase in the number of people who registered as sick. It is not likely due to improved diagnostics, but rather to the fact that more people needed to take sick leave. In November 2001, the leader of the KD party, Alf Svensson, commented that "sick-cheating" was one explanation. In contrast to earlier trends, the increase in sickness appears to be greater in more sparsely populated regions. In the beginning of the 80s, it was considered healthy to live in the countryside, since people were healthier there. A closer analysis of sick leave data in different counties shows that the Northern counties and the Gotland island were the last counties to show an increase in sick leave rates. These counties did not show increasing rates until February 1998. In contrast, the increase was observed early on in Blekinge and Kronoborg, where the increase was noticeable in September/October of 1997.
7. The number of new brain tumours in people >60 years old suddenly increased after 2000 (Fig. 7). This development paralleled the increase of melanoma in the face region of people <60 years. In general, the incidence of brain tumours is increasing most in more sparsely populated regions where mobile phones often need to use full output power [2,4].
8. The percentage of newborns with heart problems began to increase after 1998 (Fig. 8). It was recently reported that fetuses and neonates react to their mother's mobile phone use with an increased pulse rate and decreased blood flow [5]. Another report published in the well-known journal *Epidemiology* [6] suggests that such mobile phone use may also influence emotional development and may increase the risk of hyperactivity, behaviour problems, and relational problems with other children up to the time that children start school.

A dramatic environmental change took place in Sweden in the autumn of 1997. At this time, GSM 1800 MHz transmitters were put into use to increase transmission capacity, especially in urban areas, see Fig. 8. Much of the population began to be exposed to 1.8 GHz microwaves both at night and during the day. In the Stockholm area, people began to steer cars using only their right hands while holding the mobile phones by their left hands. The Post- and Telecom Administration states that GSM 1800 MHz began to be used in 1997, but has no information on starting months in different counties. When Telia were queried about starting dates

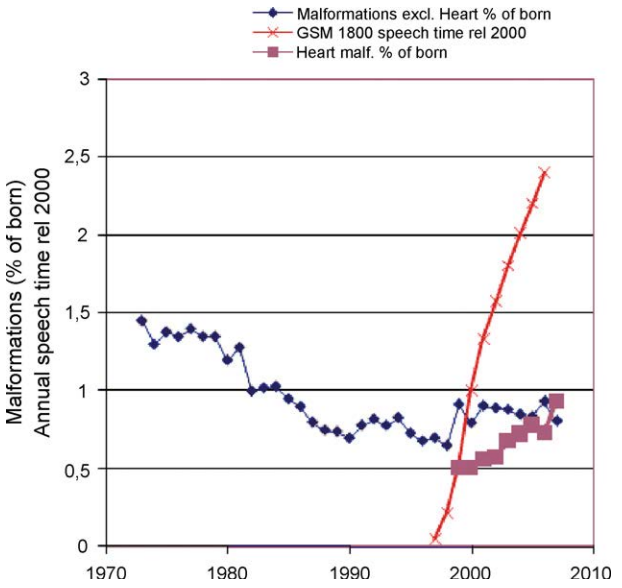

Fig. 8. The percentage of newborns with heart problems has increased since 1998 in Sweden. Also shown is the annual speech time in dual band mobile phones relative to year 2000. The down going trend of malformed newborns excluding heart problems is now broken since 1998.

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for transmitter operation, Telia responded that they will not release this information. "The reason is that this information reasonably has no association with sick registration levels in Sweden in 1997." In 2001, the roll-out of the 3G network started and the use of the higher and probably more biological hazardous frequency, around 2.1 GHz, increased. More details about relevant events in 1997 are described in reference [1].

4. Conclusion

The negative trends in public health indicators in Sweden are not fully explained by better diagnostics, better instrumentation, or better doctors. Because these indicators may reflect real world changes, efforts should be made, starting immediately, to determine the underlying cause or causes.

Conflict of interest

There is no conflict of interest known to the authors related to this work.

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References

[1] Ö. Hallberg, O. Johansson, 1997—A curious year in Sweden, Eur. J. Cancer Prev. 13 (2004) 535–538.
[2] Ö. Hallberg, Adverse health indicators correlating with sparsely populated areas in Sweden, Eur. J. Cancer Prev. 16 (2007) 71–76, Abstract.
[3] Ö. Hallberg, O. Johansson, Alzheimer mortality—why does it increase so fast in sparsely populated areas? Eur. Biol. Bioelectromagnetics. 1 (2005) 225–246.
[4] Ö. Hallberg, Increasing incidence of brain tumors in sparsely populated areas, Pathophysiology 14 (2007) 121–122.
[5] A.Y. Rezk, K. Abdulqawi, R.M. Mustafa, T.M. Abo El-Azm, H. Al-Inany, Fetal and neonatal responses following maternal exposure to mobile phones, Saudi Med. J. 29 (2008) 218–223.
[6] H.A. Divan, L. Kheifets, C. Obel, J. Olsen, Prenatal and postnatal exposure to cell phone use and behavioral problems in children, Epidemiology 19 (2008) 523–529.

Please cite this article in press as: Ö. Hallberg, O. Johansson, Apparent decreases in Swedish public health indicators after 1997—Are they due to improved diagnostics or to environmental factors? Pathophysiology (2009), doi:10.1016/j.pathophys.2008.12.004

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Public health implications of wireless technologies

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Abstract

Global exposures to emerging wireless technologies from applications including mobile phones, cordless phones, DECT phones, WI-FI, WLAN, WiMAX, wireless internet, baby monitors, and others may present serious public health consequences. Evidence supporting a public health risk is documented in the BioInitiative Report. New, biologically based public exposure standards for chronic exposure to low-intensity exposures are warranted. Existing safety standards are obsolete because they are based solely on thermal effects from acute exposures. The rapidly expanding development of new wireless technologies and the long latency for the development of such serious diseases as brain cancers means that failure to take immediate action to reduce risks may result in an epidemic of potentially fatal diseases in the future. Regardless of whether or not the associations are causal, the strengths of the associations are sufficiently strong that in the opinion of the authors, taking action to reduce exposures is imperative, especially for the fetus and children. Such action is fully compatible with the precautionary principle, as enunciated by the Rio Declaration, the European Constitution Principle on Health (Section 3.1) and the European Union Treaties Article 174.

Keywords: Wireless technology; Brain cancer; Radiofrequency; Cell phones; Wireless antenna facilities; Childrens' health

1. Introduction and background

Exposure to electromagnetic fields (EMF) has been linked to a variety of adverse health outcomes that may have significant public health consequences [1–13]. The most serious health endpoints that have been reported to be associated with extremely low frequency (ELF) and/or RF include childhood and adult leukemia, childhood and adult brain tumors, and increased risk of the neurodegenerative diseases, Alzheimer's and amyotrophic lateral sclerosis (ALS). In addition, there are reports of increased risk of breast cancer in both men and women, genotoxic effects (DNA damage and micronucleation), pathological leakage of the blood–brain barrier, altered immune function including increased allergic and inflammatory responses, miscarriage and some cardiovascular effects [1–13]. Insomnia (sleep disruption) is reported in studies of people living in very low-intensity RF environments with WI-FI and cell tower-level exposures [85–93]. Short-term effects on cognition, memory and learning, behavior, reaction time, attention and concentration, and altered brainwave activity (altered EEG) are also reported in the scientific literature [94–107]. Biophysical mechanisms that may account for such effects can be found in various articles and reviews [136–144].

The public health implications of emerging wireless technologies are enormous because there has been a very rapid global deployment of both old and new forms in the last 15 years. In the United States, the deployment of wireless infrastructure has accelerated greatly in the last few years with 220,500 cell sites in 2008 [14–16]. Eighty-four percent of the population of the US own cell phones [16]. Annualized wireless revenues in 2008 will reach $144 billion and US spending on wireless communications will reach $212 billion by 2008. Based on the current 15% annual growth rate enjoyed by the wireless industry, in the next 5 years wireless will become a larger sector of the US economy than both the agriculture and automobile sectors. The annualized use of cell phones in the US is estimated to be 2.23 trillion minutes in 2008 [16]. There are 2.2 billion users of cell phones worldwide in 2008 [17] and many million more users of cordless phones.

Over 75 billion text messages were sent in the United States, compared with 7.2 billion in June 2005, according to

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CTIA, the Wireless Association, the leading industry trade group [16]. The consumer research company Nielsen Mobile, which tracked 50,000 individual customer accounts in the second quarter of this year, found that Americans each sent or received 357 text messages a month then, compared with 204 phone calls. That was the second consecutive quarter in which mobile texting significantly surpassed the number of voice calls [17].

The Electronics Industries Alliance (EIA) represents 80% of the $550 billion US electronics industry "that provides two million jobs for American workers." Its members include companies from the consumer electronics and telecommunications industries, among others [17].

There is intense industry competition for market share. Telecom taxes form an immense revenue generator for the government sector. Sale of the airwaves (auctions selling off wireless bandwidth) is a multi-million dollar industry for governments, and multi-billion dollar global advertising budgets are common. Lobbying dollars from the telecom-related industries are estimated to be $300 million annually. The media is nearly silent on health issues, perhaps in part because of global advertising revenues that compromise journalistic independence and discourage balanced coverage of health, equity and economic issues.

2. Evidence supporting a public health risk

Even if there is only a small risk to health from chronic use of and exposure to wireless technologies, there is the potential for a profound public health impact. RF radiation now saturates the airwaves, resulting in exposure to both users and non-users. The effects are both short-term (sleep disruption, hormone disruption, impairment of cognitive function, concentration, attention, behavior, and well-being) and they are almost certainly long-term (generational impacts on health secondary to DNA damage, physiological stress, altered immune function, electrosensitivity, miscarriage risks, effects on sperm quality and motility leading to infertiility, increased rates of cancer, and neurological diseases including Alzheimer's disease and ALS—at least for ELF exposures). (Chapters 5–12 of the BioInitiative Report [1] and papers in this Supplement.)

There is credible scientific evidence that RF exposures cause changes in cell membrane function, metabolism and cellular signal communication, as well as activation of proto-oncogenes and triggering of the production of stress proteins at exposure levels below current regulatory limits. There is also generation of reactive oxygen species, which cause DNA damage, chromosomal aberrations and nerve cell death. A number of different effects on the central nervous system have also been documented, including activation of the endogenous opioid systems, changes in brain function including memory loss, slowed learning, motor dysfunction and performance impairment in children, and increased frequency of headaches, fatigue and sleep disorders. Melatonin secretion is reduced, resulting in altered circadian rhythms and disruption of several physiological functions. (Chapters 5–12 of the BioInitiative Report [1] and papers in this Supplement.)

These effects can reasonably be presumed to result in adverse health effects and disease with chronic and uncontrolled exposures, and children may be particularly vulnerable [1,19]. The young are also largely unable to remove themselves from such environments. Second-hand non-ionizing radiation, like second-hand smoke may be considered of public health concern based on the evidence at hand.

2.1. Malignant brain tumors

At present, the most persuasive evidence for cancer resulting from RF exposure is that there is a significantly increased risk of malignant glioma in individuals that have used a mobile phone for 10 or more years, with the risk being elevated only on the side of the head on which the phone is used regularly (ipsilateral use) [1,3,4,6–8,18]. While the risk for adults after 10 or more years of use is reported to be more than doubled, there is some evidence beginning to appear that indicates that the risk is greater if the individual begins to use a mobile phone at younger ages. Hardell et al. [18] reported higher odds ratios in the 20–29-year-old group than other age ranges after more than 5 years of use of either analog or cordless phones. Recently in a London symposium Hardell reported that after even just 1 or more years of use there is a 5.2-fold elevated risk in children who begin use of mobile phones before the age of 20 years, whereas for all ages the odds ratio was 1.4. Studies from Israel have found that the risk of parotid gland tumors (a salivary gland in the cheek) is increased with heavy cell phone use [7]. The risk of acoustic neuroma (a benign but space-occupying tumor on the auditory nerve) is also significantly increased on the ipsilateral side of the head after 10 or more years of mobile phone use [1,3]. This relationship has also been documented in some of the published reports of the WHO Interphone Study, a decade-long 13-country international assessment of cell phone risks and cancer [6,8].

Kundi reports that "(E)pidemiological evidence compiled in the last 10 years starts to indicate an increased risk, in particular for brain tumors (glioma, meningioma, acoustic neuroma), from mobile phone use. Considering biases that may have been operating in most studies the risk estimates are rather too low, although recall bias could have increased risk estimates. The net result, when considering the different errors and their impact is still an elevated risk" [19].

The latency for most brain tumors is 20 years or more when related to other environmental agents, for example, to X-ray exposure. Yet, for cell phone use the increased risks are occurring much sooner than twenty years, as early as 10 years for brain tumors in adults and with even shorter latencies in children. This suggests that we may currently be significantly underestimating the impact of current levels of

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use of RF technology, since we do not know how long the average latency period really is. If it is 20 years, then the risk rate will likely be much higher than an overall doubling of risk for cell phone users if the peak comes later than 10 years. It may also signal very troubling risks for those who start using cell phones, and perhaps all wireless devices, in early childhood. We may not have proof of effect for decades until many hundreds of thousands of new cases of malignant gliomas are set in motion by long-term cell phone use.

The preliminary evidence that mobile phone use at younger ages may lead to greater risk than for older persons is of particular concern. There is a large body of evidence that childhood exposure to environmental agents poses greater risk to health than comparable exposure during adulthood [20,21]. There is reason to expect that children would be more susceptible to the effects of EMF exposure since they are growing, their rate of cellular activity and division is more rapid, and they may be more at risk for DNA damage and subsequent cancers. Growth and development of the central nervous system is still occurring well into the teenage years so that neurological changes may be of great importance to normal development, cognition, learning, and behavior.

A greater vulnerability of children to developing brain cancer from mobile phone use may be the consequence of a combination of patterns of use, stage of development and physical characteristics related to exposure. In addition to the fact that the brain continues to develop through the teen years, many young children and teenagers now spend very large periods of time using mobile phones. The brain is the main target organ of cell phones and cordless phones, with highest exposure to the same side as the phone is used. Further, due to anatomical reasons, the brain of a child is more exposed to RF radiation than the brain of an adult [22,23]. This is caused by the smaller brain size, a thinner pinna of the ear, thinner skin and thinner skull bone permitting deeper penetration into the child's brain. A recent French study showed that children absorb twice the RF from cell phone use as do adults [24].

In addition to concerns about cancer, there is evidence for short-term effects of RF exposure on cognition, memory and learning, behavior, reaction time, attention and concentration, altered brainwave activity (altered EEG) [95–108], and all of these effects argue for extreme caution with regard to exposure of children. The development of children into adults is characterized by faster cell division during growth, the long period needed to fully develop and mature all organ systems, and the need for properly synchronized neural development until early adulthood. Chronic, cumulative RF exposures may alter the normal growth and development of children and adversely affect their development and capacity for normal learning, nervous system development, behavior and judgment [1,97,102].

Prenatal exposure to EMF has been identified as a possible risk factor for childhood leukemia (1). Maternal use of cell phones has been reported to adversely affect fetal brain development, resulting in behavioral problems in those children by the time they reach school age [25]. Their exposure is involuntary in all cases. Children are largely unable to remove themselves from exposures to harmful substances in their environments.

2.2. Plausible biological mechanisms for a relationship between RF exposure and cancer

2.2.1. DNA damage and oxidative stress

Damage to DNA from ELF and from RF cell phone frequencies at very low intensities (far below FCC and ICNIRP safety limits) has been demonstrated in many studies [1,2,26–35]. Both single- and double-strand DNA damage have been reported by various researchers in different laboratories. This is damage to the human genome, and can lead to mutations which can be inherited, or which can cause cancer, or both.

Non-ionizing radiation is assumed to be of too low energy to cause direct DNA damage. However both ELF and RF radiation induce reactive oxygen species, free radicals that react with cellular molecules including DNA. Free-radical production and/or the failure to repair DNA damage (secondary to damage to the enzymes that repair damage) created by such exposures can lead to mutations. Whether it is greater free-radical production, reduction in anti-oxidant protection or reduced repair capacity, the result will be altered DNA, increased risk of cancer, impaired or delayed healing, and premature aging [36–54]. Exposures have also been linked to decreased melatonin production, which is a plausible biological mechanism for decreased cancer surveillance in the body, and increased cancer risk [34,39,44,46,47,49,50,54]. An increased risk of cancers and a decrease in survival has been reported in numerous studies of ELF and RF [55–69].

2.2.2. Stress proteins (heat shock proteins or HSP)

Another well-documented effect of exposure to low-intensity ELF and RF is the creation of stress proteins (heat shock proteins) that signal a cell is being placed under physiological stress) [70–80]. The HSP response is generally associated with heat shock, exposure to toxic chemicals and heavy metals, and other environmental insults. HSP is a signal of cells in distress. Plants, animals and bacteria all produce stress proteins to survive environmental stressors like high temperatures, lack of oxygen, heavy metal poisoning, and oxidative stress.

We can now add ELF and RF exposures to this list of environmental stressors that cause a physiological stress response. Very low-level ELF and RF exposures can cause cells to produce stress proteins, meaning that the cell recognizes ELF and RF exposures as harmful. This is another important way in which scientists have documented that ELF and RF exposures can be harmful, and it happens at levels far below the existing public safety standards. An additional concern is that if the stress goes on too long, the protective effect is diminished. The reduced response with prolonged exposure means the cell is less protected against

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damage, and this is why prolonged or chronic exposures may be harmful, even at very low intensities.

2.2.3. RF-induced gene expression changes

Many environment agents cause diseases, including cancer, not by direct damage to DNA but rather by up- or down-regulation of genes that regulate cell growth and function. Usually there are many genes whose expression is changed, and it is difficult to determine the exact changes responsible for the disease. Both ELF and RF exposures have been shown to result in altered gene expression. Olivares-Banuelos et al. [81] found that ELF exposure of chromaffin cells resulted in changed expression of 53 transcripts. Zhao et al. [82] investigated the gene expression profile of rat neurons exposed to 1800 MHz RF fields (2 W/kg) and found 24 up-regulated genes and 10 down-regulated genes after a 24-h exposure. The altered genes were involved in multiple cellular functions including cytoskeleton, signal transduction pathways and metabolism. Kariene et al. [83] exposed human skin to mobile phone radiation, and found by punch biopsy that 8 proteins were significantly altered in expression, consistent with gene induction. Several other studies have found altered gene expression following RF exposure, although none have been found that explain specific disease states [84].

DNA activation at very low ELF and RF levels, as in the stress response, and DNA damage (strand breaks and micronuclei) at higher levels, are molecular precursors to changes that are believed to lead to cancer. These, along with gene induction, provide plausible biological mechanisms linking exposure to cancer.

The biochemical pathways that are activated are the same for ELF and for RF exposures, and are non-thermal (do not require heating or induced electrical currents). This is true for the stress response, DNA damage, generation of reactive oxygen species as well as gene induction. Thus it is not surprising that the major cancers resulting from exposure to ELF and RF are the same, namely leukemia and brain cancer. The safety standards for both ELF and RF, based on protection from heating, are irrelevant and not protective. ELF exposure levels of only 5–10 mG have been shown to activate the stress response genes (http://www.bioinitiative.org, Sections 1 and 7 [1]).

3. Sleep, cognitive function and performance

The relationship of good sleep to cognition, performance and healing is well recognized. Sleep is a profoundly important factor in proper healing, anti-inflammatory benefits, reduction in physical symptoms of such as tendonitis, over-use syndrome, fatigue-induced lethargy, cognition and learning. Incomplete or slowed physiological recovery is common when sleep is impaired. Circadian rhythms that normalize stress hormone production (cortisol, for example) depend on synchronized sleep patterns.

People who are chronically exposed to low-level wireless antenna emissions report symptoms such as problems in sleeping (insomnia), as well as other symptoms that include fatigue, headache, dizziness, grogginess, lack of concentration, memory problems, ringing in the ears (tinnitus), problems with balance and orientation, and difficulty in multi-tasking [85–93,99]. In children, exposures to cell phone radiation have resulted in changes in brain oscillatory activity during some memory tasks [97,102]. Cognitive impairment, loss of mental concentration, distraction, speeded mental function but lowered accuracy, impaired judgment, delayed reaction time, spatial disorientation, dizziness, fatigue, headache, slower motor skills and reduced learning ability in children and adults have all been reported [85–108].

These symptoms are more common among "electrosensitive" individuals, although electrosensitivity has not been documented in double-blind tests of individual identifying themselves as being electrosensitive as compared to controls [109,110]. However people traveling to laboratories for testing are pre-exposed to a multitude of RF and ELF exposures, so they may already be symptomatic prior to actual testing. There is also evidence that RF exposures testing behavioral changes show delayed results; effects are observed after termination of RF exposure. This suggests a persistent change in the nervous system that may be evident only after time has passed, so is not observed during a short testing period.

3.1. Plausible biological mechanisms for neurobehavioral effects

3.1.1. The melatonin hypothesis

While there remains controversy as to the degree that RF and ELF fields alter neurobehavioral function, emerging evidence provides a plausible mechanism for both effects on sleep and cognition. Sleep is controlled by the central circadian oscillator in the suprachiasmatic nucleus, located in the hypothalamus. The activity of this central circadian oscillator is, in turn, controlled by the hormone, melatonin, which is released from the pineal gland [111]. There is considerable evidence that ELF exposure reduces the release of melatonin from the pineal gland—see Section 12 of the Bioinitiative Report [1]. There has been less study of the effects of RF exposure on melatonin release, but investigations have demonstrated a reduced excretion of the urinary metabolite of melatonin among persons using a mobile phone for more than 25 min per day [112]. In a study of women living near to radio and television transmitters, Clark et al. [113] found no effect on urinary melatonin metabolite excretion among pre-menopausal women, but a strong effect in post-menopausal women.

The "melatonin hypothesis" also provides a possible basis for other reported effects of EMFs. Melatonin has important actions on learning and memory, and inhibits electrophysiological components of learning in some but not all areas of the brain [114,115]. Melatonin has properties as a free-radical scavenger and anti-oxidant [116], and consequently,

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a reduction in melatonin levels would be expected to increase susceptibility to cancer and cellular damage. Melatonin could also be the key to understanding the relationship between EMF exposure and Alzheimer's disease. Noonan et al. [117] reported that there was an inverse relationship between excretion of the melatonin metabolite and the 1–42 amino acid form of amyloid beta in electric utility workers. This form of amyloid beta has been found to be elevated in Alzheimer's patients.

3.1.2. Blood–brain barrier alterations

Central nervous system effects of EMFs may also be secondary to damage to the blood–brain barrier (BBB). The blood–brain barrier is a critical structure that prevents toxins and other large molecules that are in peripheral blood from having access to the brain matter itself. Salford et al. [118] have reported that a 2-h exposure of rats to GSM-900 radiation with a SAR of 2–200 mW/kg resulted in nerve cell damage. In a follow-up study, Eberhardt et al. report that 2-h exposures to cell phone GSM microwave RF resulted in leakage of albumin across the blood–brain barrier and neuronal death [119]. Neuronal albumin uptake was significantly correlated to occurrence of damaged neurons when measured at 28 days post-exposure. The lowest exposure level was 0.12 mW/kg (0.00012 W/kg) for 2 h. The highest exposure level was 120 mW/kg (0.12 W/kg). The weakest exposure level showed the greatest effect in opening the BBB [118]. Earlier blood–brain studies by Salford and Schirmacher [120,121] report similar effects.

4. What are sources of wireless radiation?

There are many overlapping sources of radiofrequency and microwave emissions in daily life, both from industrial sources (like cell towers) and from personal items [cell and cordless phones, personal digital assistants (PDAs), wireless routers, etc.]. Published data on typical levels found in some cities and from some sources are available at http://www.bioinitiative.org [1,122–124].

Cell phones are the single most important source of radiofrequency radiation to which we are exposed because of the relatively high exposure that results from the phone being held right against the head. Cell phones produce two types of emissions that should be considered. First, the radiofrequency radiation (typically microwave frequency radiation) is present. However, there is also the contribution of the switching battery pack that produces very high levels of extremely low frequency electromagnetic field [125–127].

Cordless telephones have not been widely recognized as similar in emissions to cell phones, but they can and do produce significant RF exposures. Since people tend to use them as substitutes for in-home and in-office corded or traditional telephones, they are often used for long periods of time. As the range of cordless phones has increased (the distance away that you can carry on a conversation is related to the power output of the phone), the more powerful the RF signal will be. Hence, newer cordless phones may in some cases be similar to the power output of cell phones. The cumulative emissions from cell and cordless phones taken together should be recognized when considering the relative risks of wireless communication exposures.

PDAs such as the BlackBerry, Treo and iPhone units are 'souped-up' versions of the original voice communication devices (cell phones). The often produce far higher ELF emissions than do cell phones because they use energy from the battery very intensively for powering color displays and during data transmission functions (email, sending and receiving large files, photos, etc.) [125–127]. ELF emissions have been reported from PDAs at several tens to several hundreds of milligauss. Evidence of significantly elevated ELF fields during normal use of the PDA has public health relevance and has been reported in at least three scientific papers [125,128,129]. In the context of repetitive, chronic exposure to significantly elevated ELF pulses from PDAs worn on the body, relevant health studies point to a possible relationship between ELF exposure and cancer and pregnancy outcomes [130–133].

We include discussion of the ELF literature for two reasons. As mentioned above ELF activates the same biology as RF, it contributes to the total EMF burden of the body. In addition, PDAs and cell phones emit both radiofrequency/microwave radiation (RF) and extremely low frequency ELF from the battery switching of the device (the power source). Studies show that some devices produce excessively high ELF exposures during voice and data transmission. ELF is already classified as a 2B (Possible) Carcinogen by IARC, which means that ELF is indisputably an issue to consider in the wireless technology debate. ELF has been classified as a Group 2B carcinogen for all humans, not just children. The strongest evidence came from epidemiological studies on childhood leukemia, but the designation applies to all humans, both adults and children [1,25].

Wireless headsets that allow for conversations with cell phones at a distance from the head itself reduce the emissions. Depending on the type of wireless device, they may operate (transmit signal) only during conversations or they may be operational continuously. The cumulative dose of wireless headsets has not been well characterized under either form of use. Substantial cumulative RF exposure would be expected if the user wears a wireless headset that transmits a signal continuously during the day. However a critical factor is where the cell phone is placed. If worn on a belt with a headset, the exposure to the brain is reduced but the exposure to the pelvis may be significant.

Cell towers (called "masts" in Europe and Scandinavian countries) are wireless antenna facilities that transmit the cell phone signals within communities. They are another major source of RF exposures for the public. They differ from RF exposures from wireless devices like cell phones in that they produce much lower RF levels (generally 0.05 to 1–2 $\mu W/cm^2$ in the first several hundred feet around them) in comparison to several hundred microwatts per centimeter

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squared for a cell phone held at the head. However they create a constant zone of elevated RF for up to 24 h per day. many hours per day, and the exposure is whole body rather than localized at the head. These facilities are the distribution system for wireless voice communications, internet connections and data transmission within communities. They are often erected on free-standing towers. They may be constructed on telephone poles or electrical poles. They may be built into the façade or rooftops of buildings behind wood screening. These are called stealth installations for wireless antenna facilities. Some installations are camouflaged to resemble 'false trees or rocks'. They emit RF to provide cell service to specific "cells" or locations that receive the signal.

Other forms of wireless transmission that are common in areas providing cell service are wireless land area networks (WLAN), (WiMAX) and WIFI networks. Some cities are installing city-wide WIFI service to allow any user on the street to log into the internet (without cables or wire connections). WIFI installations may have a signal reach for a few hundred feet where WiMAX installations may transmit signal more than 10 miles, so produce a stronger RF emission for those in close proximity. Each type has its particular signal strength and intended coverage area, but what they have in common is the production of continuous RF exposure for those within the area. We do not know what the cumulative exposure (dose) might be for people living, working or going to school in continuously elevated RF fields, nor are the possible health implications yet known. However, based on studies of populations near cell sites in general, there is a constellation of generally observed health symptoms that are reported to occur [85–107]. In this regard it is important to note that children living near to AM radio transmitters have been found to elevated risks of leukemia [134,135]. While AM radio RF fields are lower in frequency than that common in mobile phones, this is a total body irradiation with RF. The fact that leukemia, not brain cancer, is apparent in these studies suggests that leukemia is the cancer seen at the lowest levels of both ELF and RF fields under the circumstances of whole-body exposure.

Commercial surveillance systems or security gates pose an additional source of strong RF exposures. They are ubiquitous in department stores, markets and shops at the entry and exit points to discourage shoplifting and theft of goods. Security gates can produce excessively high RF exposures (although transitory) and have been associated with interference with pacemakers in heart patients. The exposure levels may approach thermal public safety limits in intensity, although no one expects a person to stand between the security gate bars for more than 6 min (safety limits for uncontrolled public access are variable depending on the frequency, but are all averaged over a 6-min exposure period).

RFID chips (radiofrequency identification chips) are being widely used to track purchases and for security of pets, and in some cases to keep track of patients with Alzheimer's disease and of children. RFID chips are implanted in fabrics, inserted in many types of commercial goods, and can be implanted under the skin. They create a detectable signal to track the location of people and goods.

5. Problems with existing public health standards (safety limits)

If the existing standards were adequate none of the effects documented above should occur at levels to which people are regularly exposed. The fact that these effects are seen with our current ambient levels of exposure means that our existing public safety standards are obsolete. It also means that new, biologically based public exposure standards for wireless technologies are urgently needed. Whether it is feasible to achieve low enough levels that still work and also protect health against effects of chronic RF exposure – for all age groups – is uncertain. Whether we can protect the public and still allow the kinds of wireless technology uses we see today is unknown.

The nature of electromagnetic field interactions with biological systems has been well studied [136–144]. For purposes of standard-setting processes for both ELF and RF, the hypothesis that tissue damage can result only from heating is the fundamental flaw in the misguided efforts to understand the basic biological mechanisms leading to health effects.

The thermal standard is clearly untenable as a measure of dose when EMF stimuli that differ by many orders of magnitude in energy can stimulate the same biological response. In the ELF range, the same biological changes occur as in the RF, and no change in temperature can even be detected. With DNA interactions the same biological responses are stimulated in ELF and RF ranges even though the frequencies of the stimuli differ by many orders of magnitude. The effects of EMF on DNA to initiate the stress response or to cause molecular damage reflect the same biology in different frequency ranges. For this reason it should be possible to develop a scale based on DNA biology, and use it to define EMF dose in different parts of the EM spectrum. We also see a continuous scale in DNA experiments that focus on molecular damage where single and double strand breaks have long been known to occur in the ionizing range, and recent studies have shown similar effects in both ELF and RF ranges [144].

Existing standard-setting bodies that regulate wireless technologies, assume that there are no bioeffects of concern at exposure levels that do not cause measurable heating. However, it has been established beyond any reasonable doubt that bioeffects and some adverse health effects occur at far lower levels of RF and ELF exposure where no heating (or induced current) occurs; some effects are shown to occur a thousand times or more below the existing public safety limits. New, biologically based public exposure limits are urgently needed. New wireless technologies for cell and cordless phones, other wireless communication and data transmission systems affect living organisms in new ways that our antiquated safety limits have not foreseen, nor protected against.

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The exposure of children to electromagnetic fields has not been studied extensively; in fact, the Federal Communications Commission (FCC) standards for exposure to radiofrequency radiation are based on the height, weight and stature of a 6-foot tall man, not scaled to children or adults of smaller stature. They do not take into account the unique susceptibility of growing children to exposures, nor are there studies of particular relevance to children.

In addition there is a problem in the consideration of the level of evidence taken into consideration by these bodies. There have not been adequate animal models shown to have cancer as an endpoint, and a perception that no single mechanism is proven to explain these associations. Thus these committees have tended to ignore or minimize the evidence for direct hazard to humans, and believe there is no proof of cause and effect. These bodies assume from the beginning that only conclusive scientific evidence (absolute proof) will be sufficient to warrant change, and refuse to take action on the basis of a growing body of evidence which provides early but consequential warning of risks.

The Radiofrequency Interagency Working Group of the US governmental agencies involved in RF matters (RFIAWG) issued a Guidelines Statement in June of 1999 that concluded the present RF standard "may not adequately protect the public" [145]. The RFIAWG identified fourteen (14) issues that they believe are needed in the planned revisions of ANSI/IEEE RF exposure guidelines including "to provide a strong and credible rationale to support RF exposure guidelines". In particular, the RFIAWG criticized the existing standards as not taking into account chronic, as opposed to acute exposures, modulated or pulsed radiation (digital or pulsed RF is proposed at this site), time-averaged measurements that may erase the unique characteristics of an intensity-modulated RF radiation that may be responsible for reported biologic effects, and stated the need for a comprehensive review of long-term, low-level exposure studies, neurological-behavioral effects and micronucleus assay studies (showing genetic damage from low-level RF) [145]. This important document from relevant US agencies questions existing standards in the following ways: (a) selection of an adverse effect level for chronic exposures not based on tissue heating and considering modulation effects; (b) recognition of different safety criteria for acute and chronic exposures at non-thermal or low-intensity levels; (c) recognition of deficiencies in using time-averaged measurements of RF that does not differentiate between intensity-modulated RF and continuous wave (CW) exposure, and *therefore may not adequately protect the public*; (d) having standards based on adult males rather than considering children to be the most vulnerable group.

6. Prudent public health responses

Emerging environmental health problems require preventative public health responses even where scientific and medical uncertainties still exist, but where policy decisions today may greatly reduce human disease and societal costs tomorrow.

Policy decisions in public health must address some amount of uncertainty when balancing likely benefits and estimated costs. Although new insight will allow better appreciation of difficult issues, such as those occurring in environmental and occupational health, an expanded perspective may also enlarge the list of problems that need to be managed. Ignoring the problems carries its own costs (as deferring a decision is a decision in itself). With environmental and other public health problems becoming increasingly complex and international in scope, scientific documentation alone rarely justifies simple solutions [146].

Social issues regarding the controversy over public and occupational exposures to ELF and RF center on the resolute adherence to existing ICNIRP and FCC/IEEE standards by many countries, in the face of growing scientific evidence of health risks at far lower levels [10]. The composition of these committees, usually with excessive representation of the physics and engineering communities rather than public health professionals, results in a refusal to adopt biologically based exposure standards. Furthermore, there is widespread belief that governments are ignoring this evidence and there is widespread distrust of and lack of confidence in governments and their health agencies. The basis on which most review bodies and standard-setting agencies have avoided the conclusion that the science is strong enough to warrant new safety limits for ELF and RF is to require a demonstration of absolute proof before taking action. A causal level of evidence, or scientific certainty standard is implicit in nearly all reviews of the ELF and RF science, although this runs counter to good public health protection policies.

There is no question that global implementation of the safety standards proposed in the Bioinitiative Report, if implemented abruptly and without careful planning, have the potential to not only be very expensive but also disruptive of life and the economy as we know it. Action must be a balance of risk to cost to benefit. The major risk from maintaining the status quo is an increasing number of cancer cases, especially in young people, as well as neurobehavioral problems at increasing frequencies. The benefits of the status quo are expansion and continued development of communication technologies. But we suspect that the true costs of even existing technologies will only become much more apparent with time. Whether the costs of remedial action are worth the societal benefits is a formula that should reward precautionary behavior. Prudent corporate policies should be expected to address and avoid future risks and liabilities, otherwise, there is no market incentive to produce safe (and safer) products.

The deployment of new technologies is running ahead of any reasonable estimation of possible health impacts and estimates of probabilities, let alone a solid assessment of risk. However, what has been missing with regard to EMF has been an acknowledgement of the risk that is demonstrated by

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the scientific studies. There is clear evidence of risk, although the magnitude of the risk is uncertain, and the magnitude of doing nothing on the health effects cost to society is similarly uncertain. This situation is very similar to our history of dealing with the hazards of smoking decades ago, where the power of the industry to influence governments and even conflicts of interest within the public health community delayed action for more than a generation, with consequent loss of life and enormous extra health care costs to society. New standards are warranted now, based on the totality of scientific evidence; the risks of taking no-action, the large population at risk, costs associated with ignoring the problem in new and upgraded site selection and construction, and the loss of public trust by ignoring the problem.

Direct medical and rehabilitative health costs associated with treatment for diseases that are reasonably related to wireless technologies may be very large. Although there is uncertainty involved in how much disease is related to wireless exposures, the mere scale of the problem with several billion users of cell phones and even larger impacts on bystander populations (from cell site exposures, from other WI-FI and wireless exposures in-home and commercial use, etc.) the associated public health costs will likely be monumental. Furthermore the costs to families with cancers, neurological diseases or learning disabilities in children related in part or in whole to wireless technologies extend beyond medical costs. They may reasonably extend to family disruption and family psychological problems, losses in job productivity and income loss.

The history of governments and their official health agencies to deal with emerging and newly identified risks to health is not good [147–149]. This is particularly true where industry investments in new products and technologies occur without full recognition, disclosure or even knowledge of possible health consequences. Large economic investments in polluting industries often make for perilously slow regulatory action, and the public health consequences may be very great as a result [150,151].

Free markets do not internalize the costs to society of "guessing wrong". Unexpected or hidden health costs of new technologies may not be seen for many years, when the ability to recall or to identify the precise exposures related to disease outcomes is difficult or impossible. The penalty nearly always falls to the individual, the family or the taxpayer and not to the industry that benefits economically—at least in free-market economies. Thus, the profits go to industry but the costs may go to the individual who can suffer both diminished quality of life and health and economic disadvantage. If all disease endpoints that may be reasonably related to chronic exposure to electromagnetic fields are considered even a small attributable fraction for one or more industries, it will have enormous global impact on public health. The public health implications are immense. But they can be reduced by strong government and public health interventions providing information on alternatives to wireless technologies, public education campaigns, health advisories, requirements for redesign of wireless devices, proscription of use of wireless devices by children and teenagers, strong and independent research programs on causes and prevention of EMF-related diseases, and consultation with all stakeholders on issues relating to involuntary exposures (bystander or second-hand radiation exposures from wireless technologies) (Table 1).

Table 1
Public health implications of wireless technologies argue for change in governmental and health agency actions.

Secure US and EU legislative mandates for safer technologies for communication and data transmission, for security and surveillance needs.
Promote wired alternatives for voice and data communication (cable, fiber-optic)
Discourage or ban use of cell phones by children and young teen-agers
Provide permanent (unremovable) labels on cell phones "Not for use by children under the age of 16"
Implement national public education campaigns on health issues (cell phones, cordless phones, PDAs, wireless internet, city-wide WI-FI, WLAN and WiMAX exposures
Promote industry redesign for safer products: support innovation for alternatives and solutions
Slow or stop deployment of wireless technologies to discourage reliance on wireless technologies for communication and security needs
Put the burden of proof on industry to show "new wireless tech" is safe before deployment
Adopt and enforce restricted use areas for sensitive or more vulnerable segments of society including low-EMF environments in public areas and "No Cell" zones in airports, hospitals, schools
Acknowledge FCC and ICNIRP thermal safety standards are obsolete for wireless technologies
Appoint new standard-setting bodies familiar with biological effects to develop new guidelines for public safety limits.
Develop new biologically based standards that address low-intensity, chronic exposures
Require standard of evidence and level of proof = public health
Reject "causal" standard of evidence for taking action on science
Make industry financially liable for "guessing wrong" and ignoring health risks

The scientific information contained in this Supplement argues for thresholds or guidelines that are substantially below current FCC and ICNIRP standards for localized exposures to wireless devices and for whole-body exposure. Uncertainty about how low such standards might have to go to be prudent from a public health standpoint should not prevent reasonable efforts to respond to the information at hand. No lower limit for bioeffects and adverse health effects from RF has been established, so the possible health risks of wireless WLAN and WI-FI systems, for example, will require further research. No assertion of safety at any level of wireless exposure (chronic exposure) can be made at this time. The lower limit for reported human health effects has dropped 100-fold below the safety standard (for mobile phones and PDAs); 1000–10,000-fold for other wireless (cell towers at distance; WI-FI and WLAN devices). The entire basis for safety standards is called into question, and it is not unreasonable to question the safety of RF at any level.

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It is likely that for both ELF and RF, as for other carcinogens, there is no threshold of exposure that is without risk, but the magnitude of the risk increases linearly with the level of exposure. Our society will not go back to the pre-electric and pre-wireless age, but the clear evidence of health hazards to the human population from exposure mandates that we develop ways in which to reduce exposure through education, new technologies and the establishment of biomedically based standards.

7. Conclusions and recommended actions

New ELF limits are warranted based on a public health analysis of the overall existing scientific evidence. These limits should reflect environmental levels of ELF that have been demonstrated to increase risk for childhood leukemia, and possibly other cancers and neurological diseases. ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor. It is no longer acceptable to build new power lines and electrical facilities that place people in ELF environments that have been determined to be risky. These levels are in the 2–4 milligauss (mG) range (0.2–0.4 μT), not in the 10 s of mG or 100 s of mG. The existing ICNIRP limit is 1000 mG (100 μT) and 904 mG (90.4 μT) in the US for ELF is outdated and based on faulty assumptions. These limits are can no longer be said to be protective of public health and they should be replaced. A safety buffer or safety factor should also be applied to a new, biologically based ELF limit, and the conventional approach is to add a safety factor lower than the risk level.

While new ELF limits are being developed and implemented, a reasonable approach would be a 1 mG (0.1 μT) planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG (0.2 μT) limit for all other new construction. It is also recommended that a 1 mG (0.1 μT) limit be established for existing habitable space for children and/or women who are pregnant (because of the possible link between childhood leukemia and *in utero* exposure to ELF). This recommendation is based on the assumption that a higher burden of protection is required for children who cannot protect themselves, and who are at risk for childhood leukemia at rates that are traditionally high enough to trigger regulatory action. This situation in particular warrants extending the 1 mG (0.1 μT) limit to existing occupied space. "Establish" in this case probably means formal public advisories from relevant health agencies. While it is not realistic to reconstruct all existing electrical distribution systems, in the short-term; steps to reduce exposure from these existing systems need to be initiated, especially in places where children spend time, and should be encouraged. These limits should reflect the exposures that are commonly associated with increased risk of childhood leukemia (in the 2–5 mG (0.2–0.5 μT) range for all children, and over 1.4 mG (0.14 μT) for children age 6 and younger). Nearly all of the occupational studies for adult cancers and neurological diseases report their highest exposure category is 4 mG (0.4 μT) and above, so that new ELF limits should target the exposure ranges of interest, and not necessarily higher ranges.

Avoiding chronic ELF exposure in schools, homes and the workplace above levels associated with increased risk of disease will also avoid most of the possible bioactive parameters of ELF discussed in the relevant literature.

It is not prudent public health policy to wait any longer to adopt new public safety limits for ELF. These limits should reflect the exposures that are commonly associated with increased risk of childhood leukemia (in the 2–5 mG (0.2–0.5 μT) range for all children, and over 1.4 mG (0.14 μT) for children age 6 and younger). Avoiding chronic ELF exposure in schools, homes and the workplace above levels associated with increased risk of disease will also avoid most of the possible bioactive parameters of ELF discussed in the relevant literature.

The rapid deployment of new wireless technologies that chronically expose people to pulsed RF at levels reported to cause bioeffects, which in turn, could reasonably be presumed to lead to serious health impacts, is a public health concern. There is suggestive to strongly suggestive evidence that RF exposures may cause changes in cell membrane function, cell communication, metabolism, activation of proto-oncogenes and can trigger the production of stress proteins at exposure levels below current regulatory limits. Resulting effects can include DNA breaks and chromosome aberrations, cell death including death of brain neurons, increased free-radical production, activation of the endogenous opioid system, cell stress and premature aging, changes in brain function including memory loss, retarded learning, performance impairment in children, headaches and fatigue, sleep disorders, neurodegenerative conditions, reduction in melatonin secretion and cancers (BioInitiative Report Chapters 5–10, 12) [1].

This information now argues for thresholds or guidelines that are substantially below current FCC and ICNIPR standards for whole-body exposure. Uncertainty about how low such standards might have to go to be prudent from a public health standpoint should not prevent reasonable efforts to respond to the information at hand. No lower limit for bioeffects and adverse health effects from RF has been established, so the possible health risks of wireless WLAN and WI-FI systems, for example, will require further research and no assertion of safety at any level of wireless exposure (chronic exposure) can be made at this time. The lower limit for reported human health effects has dropped 100-fold below the safety standard (for mobile phones and PDAs); 1000–10,000-fold for other wireless (cell towers at distance; WI-FI and WLAN devices). The entire basis for safety standards is called into question, and it is not unreasonable to question the safety of RF at any level.

A cautionary target level for pulsed RF exposures for ambient wireless that could be applied to RF sources from cell tower antennas, WI-FI, WI-MAX and other similar sources

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is proposed. The recommended cautionary target level is 0.1 microwatts per centimeter squared ($\mu W/cm^2$) (or 0.614 V per meter or V/m) for pulsed RF where these exposures affect the general public; this advisory is proportionate to the evidence and in accord with prudent public health policy. A precautionary limit of 0.1 $\mu W/cm^2$ should be adopted for outdoor, cumulative RF exposure. This reflects the current RF science and prudent public health response that would reasonably be set for pulsed RF (ambient) exposures where people live, work and go to school. This level of RF is experienced as whole-body exposure, and can be a chronic exposure where there is wireless coverage present for voice and data transmission for cell phones, pagers and PDAs and other sources of radiofrequency radiation. An outdoor precautionary limit of 0.1 $\mu W/cm^2$ would mean an even lower exposure level inside buildings, perhaps as low as 0.01 $\mu W/cm^2$. Some studies and many anecdotal reports on ill health have been reported at lower levels than this; however, for the present time, it could prevent some of the most disproportionate burdens placed on the public nearest to such installations. Although this RF target level does not preclude further rollout of WI-FI technologies, we also recommend that wired alternatives to WI-FI be implemented, particularly in schools and libraries so that children are not subjected to elevated RF levels until more is understood about possible health impacts. This recommendation should be seen as an interim precautionary limit that is intended to guide preventative actions; and more conservative limits may be needed in the future.

Broadcast facilities that chronically expose nearby residents to elevated RF levels from AM, FM and television antenna transmission are also of public health concern given the potential for very high RF exposures near these facilities (antenna farms). RF levels can be in the 10 s to several 100 s of $\mu W/cm^2$ in residential areas within half a mile of some broadcast sites (for example, Lookout Mountain, Colorado and Awbrey Butte, Bend, Oregon). Like wireless communication facilities, RF emissions from broadcast facilities that are located in, or expose residential populations and schools to elevated levels of RF will very likely need to be re-evaluated for safety.

For emissions from wireless devices (cell phones, personal digital assistant or PDA devices, etc.) there is enough evidence for increased risk of brain tumors and acoustic neuromas now to warrant intervention with respect to their use. Redesign of cell phones and PDAs could prevent direct head and eye exposure, for example, by designing new units so that they work only with a wired headset or on speakerphone mode.

These effects can reasonably be presumed to result in adverse health effects and disease with chronic and uncontrolled exposures, and children may be particularly vulnerable. The young are also largely unable to remove themselves from such environments. Second-hand radiation, like second-hand smoke is an issue of public health concern based on the evidence at hand.

In summary, the following recommendations are made:

- ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor. It is no longer acceptable to build new power lines and electrical facilities that place people in ELF environments that have been determined to be risky (at levels generally at 2 mG (0.2 μT) and above).
- While new ELF limits are being developed and implemented, a reasonable approach would be a 1 mG (0.1 μT) planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG (0.2 μT) limit for all other new construction, It is also recommended for that a 1 mG (0.1 μT) limit be established for existing habitable space for children and/or women who are pregnant. This recommendation is based on the assumption that a higher burden of protection is required for children who cannot protect themselves, and who are at risk for childhood leukemia at rates that are traditionally high enough to trigger regulatory action. This situation in particular warrants extending the 1 mG (0.1 μT) limit to existing occupied space. "Establish" in this case probably means formal public advisories from relevant health agencies.
- While it is not realistic to reconstruct all existing electrical distributions systems, in the short-term; steps to reduce exposure from these existing systems need to be initiated and should be encouraged, especially in places where children spend time.
- A precautionary limit of 0.1 $\mu W/cm^2$ (which is also 0.614 V per meter) should be adopted for outdoor, cumulative RF exposure. This reflects the current RF science and prudent public health response that would reasonably be set for pulsed RF (ambient) exposures where people live, work and go to school. This level of RF is experienced as whole-body exposure, and can be a chronic exposure where there is wireless coverage present for voice and data transmission for cell phones, pagers and PDAs and other sources of radiofrequency radiation. Some studies and many anecdotal reports on ill health have been reported at lower levels than this; however, for the present time, it could prevent some of the most disproportionate burdens placed on the public nearest to such installations. Although this RF target level does not preclude further rollout of WI-FI technologies, we also recommend that wired alternatives to WI-FI be implemented, particularly in schools and libraries so that children are not subjected to elevated RF levels until more is understood about possible health impacts. This recommendation should be seen as an interim precautionary limit that is intended to guide preventative actions; and more conservative limits may be needed in the future.

References

[1] C. Sage, D.O. Carpenter (Eds.), BioInitiative Working Group BioInitiative Report: A Rationale for a Biologically-based Public

Please cite this article in press as: C. Sage, D.O. Carpenter, Public health implications of wireless technologies, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.01.011

Exposure Standard for Electromagnetic Fields (ELF and RF), 2007. http://www.bioinitiative.org.

[2] REFLEX Program. Risk evaluation of potential environmental hazards from low frequency electromagnetic field exposure using sensitive in vitro methods. A project funded by the European Union under the programme Quality of Life and Management of Living Resources, Key Action 4 (2004).

[3] L. Hardell, C. Sage, Biological effect from electromagnetic field exposure and public exposure standards, Biomed. Pharmacother. 62 (2008) 104–109, doi:10.1016/j.bipha.(2007)12.004.

[4] L. Hardell, M. Carlberg, F. Söderqvist, K. Hansson Mild, Meta-analysis of long-term mobile phone use and the association with brain tumours, Int. J. Oncol. 32 (2008) 1097–1103.

[5] P. Kan, S.E. Simonsen, J.L. Lyon, J.R.W. Kestle, Cellular phone use and brain tumor: a meta-analysis, J. Neurooncol. (2007), doi:10.1007/s11060-007-9432-1.

[6] E. Cardis, Interphone Study Memo, International Agency for Cancer Research, October 2008.

[7] S. Sadetzki, A. Chetrit, A. Jarus-Hakak, E. Cardis, Y. Deutch, S. Dvendevani, A. Zultan, I. Novikov, L. Freedman, M. Wolf, Cellular phone use and risk of benign and malignant parotid gland tumors—a nationwide case–control study, Am. J. Epidemiol. (2008), doi:10.1093/aje/kwm325.

[8] A. Lahkola, T. Salminen, J. Raitanen, S. Heinavaara, M.J. Schoemaker, H.C. Christensen, M. Feychting, C. Johansen, L. Klaeboe, S. Lonn, A.J. Swerdlow, T. Tynes, A. Auvinen, Meningioma and mobile phone use—a collaborative case–control study in five North European countries, Int. J. Epidemiol. Adv. Access (August) (2008), doi:10.1093/ije/dyn155.

[9] T. Takebayashi, S. Akiba, Y. Kikuchi, et al., Mobile phone use and acoustic neuroma risk in Japan, Occup. Environ. Med. 63 (2007) 802–807.

[10] D.O. Carpenter, C.L. Sage, Setting prudent public health policy for electromagnetic field exposures, Rev. Environ. Health 23 (2) (2008) 91–117.

[11] D.O. Carpenter, C.L. Sage, BioInitiative Working Group, Key scientific evidence and public health policy options, BioInitiative Report at http://www.bioinitiative.org, 17 (2007).

[12] European Commission, Health and Consumer Protection, Scientific Committee on SCENIHR Report on Emerging and Newly Identified Health Risks—Possible Effects of Electromagnetic Fields (EMF) on Human Health, 2007.

[13] World Health Organization, Extremely Low Frequency Fields Environmental Health Criteria Monograph 238, 2007. http://www.who.int/peh-emf/project/en and http://www.who.int/peh-emf/meetings/elf_emf_workshop_2007/en/index.html.

[14] http://news.cnet.com/Emerging-markets-fuel-cell-phone-growth/2100-1039_3-6159491.html.

[15] http://news.softpedia.com/news/2-14-billion-cell-phone-subscribers-in-2005-2120.shtml.

[16] http://www.ctia.org/media/industry_info/index.cfm/AID/10323.

[17] http://www.nytimes.com/2008/09/20/us/20messaging.html and Members Info. Electronics Industries Alliance Website, November, 2000.;
Members Info, Electronics Industries Alliance Website, November 2000.

[18] L. Hardell, M. Carlberg, K. Hansson Mild, Pooled analysis of two case–control studies on use of cellular and cordless telephones and the risk for malignant brain tumours diagnosed in 1997–2003, Int. Arch. Environ. Health 79 (2006) 630–639, doi:10.1007/s00420-006-0088-5.

[19] M. Kundi, The controversy about a possible relationship between mobile phone use and cancer, Environ. Health Persp. (September) (2008), doi: 101289/ehp.11902.

[20] J. Pronczuk-Garbino (Ed.), Children's Health and the Environment: A Global Perspective, World Health Organization, Geneva, Switzerland, 2005, p. 367.

[21] World Health Organization, Children's Health and Environment: A Review of Evidence: A Joint Report from the European Environmental Agency and The World Health Organization, 2002. http://www.who.int/peh-emf.

[22] O.P. Gandhi, G. Lazzi, C.M. Furse, Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz, IEE Trans. Microw. Theory Tech. 44 (1996) 1884–1896.

[23] O.P. Gandhi, G. Kang, Some present problems and a proposed experimental phantom for SAR compliance testing of cellular telephones at 835 and 1900 MHz, Phys. Med. Biol. 47 (2002) 1501–1518.

[24] J. Wiart, A. Hadjem, M.F. Wong, I. Bloch, Analysis of RF exposure in the head tissues of children and adults, Phys. Med. Biol. 53 (2008) 3681–3695;
J. Wiatt, A. Hadjem, M.F. Wong, I. Bloch, Analysis of RF exposure in the head tissues of children and adults, Wiatt Phys. Med. Biol. 53 (June) (2008) 2771–2783.

[25] H.A. Divan, L. Kheifets, C. Obel, J. Olsen, Prenatal and postnatal exposure to cell phone use and behavioral problems in children, Epidemiology 19 (4) (2008).

[26] International Commission on Non-ionizing Radiation Protection, Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). Health Phys. 74(4) (1998) 494–522. http://www.icnirp.de.

[27] Institute of Electrical and Electronics Engineers, Inc (IEEE), Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE C95.1-1992. New York, NY, 1992.

[28] H. Lai, N.P. Singh, Single and double strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation, Int. J. Radiat. Biol. 69 (1996) 513–521.

[29] S. Ivancsits, A. Pilger, E. Diem, O. Jahn, H.W. Rudinger, Cell type-specific genotoxic effects of intermittent extremely-low frequency electromagnetic fields, Mutat. Res. 583 (2005) 184–188.

[30] J. Phillips, et al., DNA damage in molt-4 lymphoblastoid cells exposed to cellular telephone radiofrequency fields in vitro, Bioelectrochem. Bioenerg. 45 (1998) 103–110.

[31] R.J. Aitken, L.E. Bennetts, D. Sawyer, A.M. Wiklendt, B.V. King, Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline, Int. J. Androl. 28 (2005) 171.

[32] J.Y. Kim, S.Y. Hong, Y.M. Lee, S.A. Yu, W.S. Koh, J.R. Hong, T. Son, S.K. Chang, M. Lee, In vitro assessment of clastogenicity of mobile-phone radiation (835 MHz) using the alkaline comet assay and chromosomal aberration test, Environ. Toxicol. 23 (2008) 319.

[33] S. Lixia, K. Yao, W. Kaijun, l. Deglang, H. Huajun, G. Xiangwei, W. Baohong, Z. Wei, L. Jianling, W. Wei, Effects of 1.8 GHz radiofrequency field on DNA damage and expression of heat shock protein 70 in human lens epithelial cells, Mutat. Res. 602 (2006) 135.

[34] R. Paulraj, J. Behari, Single strand DNA breaks in rat brain cells exposed to microwave radiation, Mutat. Res. 596 (2006) 76.

[35] M. Mashevich, D. Folkman, A. Kesar, A. Barbul, R. Korenstein, E. Jerby, L. Avivi, Exposure of human peripheral blood lymphocytes to electromagnetic fields associated with cellular phones leads to chromosomal instability, Bioelectromagnetics 24 (2003) 82.

[36] I.G. Akoev, M.S. Pashovkina, L.P. Dolgacheva, T.P. Semenova, V.L. Kalmykov, Enzymatic activity of some tissues and blood serum from animals and humans exposed to microwaves and hypothesis on the possible role of free radical processes in the nonlinear effects and modification of emotional behavior of animals, Radiat. Biol. Radioecol. 42 (3) (2002) 32–330.

[37] C. Blackman, et al., The influence of 1.2 μT, 60 Hz magnetic fields on melatonin and tamoxifen-induced inhibition of MCF-7 cell growth, Bioelectromagnetics 22 (2) (2001) 122–128.

[38] D.E. Blask, S.M. Hill, Effects of melatonin on cancer: studies on MCF-7 human breast cancer cells in culture, J. Neural Transm. Suppl. 21 (1986) 433–449.

Please cite this article in press as: C. Sage, D.O. Carpenter, Public health implications of wireless technologies, Pathophysiology (2009), doi:10.1016/j.pathophys.2009.01.011

[39] J.B. Burch, J.S. Reif, C.W. Noonan, T. Ichinose, A.M. Bachand, T.L. Koleber, M.G. Yost, Melatonin metabolite excretion among cellular telephone users, Int. J. Rad. Biol. 78 (2002) 1029–1036.
[40] Girgert, et al., Induction of tamoxifen resistance in breast cancer cells by ELF electromagnetic fields, Biochem. Biophys. Res. Commun. 336 (2005) 1144–1149.
[41] Harland, et al., Environmental magnetic fields inhibit the antiproliferative action of tamoxifen and melatonin in a human breast cancer cell line, Bioelectromagnetics 18 (1997) 555–562.
[42] Harland, et al., Evidence for a slow time-scale of interaction for magnetic fields inhibiting tamoxifen's antiproliferative action in human breast cancer cells, Cell Biochem. Biophys. 31 (3) (1999) 295–306.
[43] A. Ilhan, A. Gurel, F. Armutcu, S. Kamisli, M. Iraz, O. Akyol, S. Ozen, Ginkgo biloba prevents mobile phone-induced oxidative stress in rat brain, Clin. Chim. Acta 340 (1–2) (2004) 153–162.
[44] Ishido, et al., Magnetic fields (MF) of 50 Hz at 1.2 μT as well as 100 μT cause uncoupling of inhibitory pathways of adenylyl cyclase mediated by melatonin 1a receptor in MF-sensitive MCF-7 cells, Carcinogenesis 22 (7) (2001) 1043–1048.
[45] H. Koylu, H. Mollaoglu, F.N. Ozguner, Melatonin modulates 900 Mhz microwave-induced lipid peroxidation changes in rat brain, Toxicol. Ind. Health 22 (5) (2006) 211–216.
[46] R.P. Liburdy, T.R. Sloma, et al., ELF magnetic fields, breast cancer, and melatonin: 60 Hz fields block melatonin's oncostatic action on ER+ breast cancer cell proliferation, J. Pineal Res. 14 (1993) 89–97.
[47] R.P. Liburdy, et al., Magnetic Fields, melatonin, tamoxifen and human breast cancer cell growth, in: R.G. Stevens, B.W. Wilson, L.E. Anderson (Eds.), The Melatonin Hypothesis—Breast Cancer and Use of Electric Power, Battelle Press, Columbus, Richland, 1997, pp. 669–700.
[48] L.I. Loberg, Gene expression in human breast epithelial cells exposed to 60 Hz magnetic fields, Carcinogenesis 20 (1999) 1633–1636.
[49] Luben, et al., Replication of 12 mG EMF effects on melatonin responses of MCF-7 breast cancer cells in vitro, in: Abstract A-1 of the 1996 Annual Review of Research on Biological Effects of Electric and Magnetic Fields from the Generation, Delivery and Use of Electricity, San Antonio, TX, November 17–21, 1996, p. 1.
[50] Luben, et al., Independent replication of 60-Hz 1.2 μT EMF effects on melatonin and tamoxifen responses of MCF-7 cells in vitro, in: Abstract A-3.4, Bioelectromagnetics Society Annual Meeting, St. Pete Beach, FL, June 7–11, 1998, pp. 17–18.
[51] Morris, In vitro exposure of MCF-7 human breast cancer cells to 60-Hz magnetic fields, in: Abstract p-125A, Bioelectromagnetics Society Annual Meeting, St. Pete Beach, FL, June 7–11, 1998, pp. 204–205.
[52] F. Oktem, F. Ozguner, H. Mollaoglu, A. Koyu, E. Uz, Oxidative damage in the kidney induced by 900-MHz-emitted mobile phone: protection by melatonin, Arch. Med. Res. 36 (4) (2005) 350–355.
[53] F. Ozguner, G. Aydin, H. Mollaoglu, O. Gokalp, A. Koyu, G. Cesur, Prevention of mobile phone induced skin tissue changes by melatonin in rat: an experimental study, Toxicol. Ind. Health 20 (6–10) (2004) 133–139.
[54] F. Ozguner, A. Altinbas, M. Ozaydin, A. Dogan, H. Vural, A.N. Kisioglu, G. Cesur, N.G. Yildirim, Mobile phone-induced myocardial oxidative stress: protection by a novel antioxidant agent caffeic acid phenethyl ester, Toxicol. Ind. Health 21 (9) (2005) 223–230.
[55] A.W. Guy, C.K. Chou, L.L. Kunz, J. Crowley. J. Krupp, Effects of long-term low-level radiofrequency radiation exposure on rats. US Air Force School of Aerospace Medicine Brooks Air Force Base, Texas TR-85-64 Final Report August 1985, Approved for public release: distribution is unlimited.
[56] C.K. Chou, Long-term low level microwave irradiation of rats, Bioelectromagnetics 13 (1992) 469–496.
[57] H. Dolk, et al., Cancer incidence near radio and television transmitters in Great Britain, Am. J. Epidemiol. 145 (1) (1997) 1–9.
[58] V. Garaj-Vrhovac, D. Horvat, Z. Koren, The relationship between colony-forming ability, chromosome aberrations and incidence of micronuclei in V79 Chinese hamster cells exposed to microwave radiation, Mutat. Res. 263 (3) (1991) 143–149.
[59] V. Garaj-Vrhovac, A. Fucic, D. Horvat, The correlation between the frequency of micronuclei and specific chromosome aberrations in human lymphocytes exposed to microwave radiation in vitro, Mutat. Res. 281 (3) (1992) 181–186.
[60] V. Garaj-Vrhovac, Micronucleus assay and lymphocyte mitotic activity in risk assessment of occupational exposure to microwave radiation, Chemosphere 39 (13) (1999) 2301–2312.
[61] M. Ha, H. Im, M. Lee, H.J. Kim, B.C. Kim, Y.M. Gimm, et al., Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer, Am. J. Epidemiol. 166 (2007) 270–279.
[62] B. Hocking, et al., Cancer incidence and mortality and proximity to TV towers, Med. J. Aust. 165 (11–12) (1996) 601–605.
[63] B. Hocking, Decreased survival for childhood leukemia in proximity to TV towers, in: Poster Presented at the Annual Scientific Meeting of the Royal Australian College of Physicians in Adelaide, SA, Australia, May, 2000.
[64] D.E. Foliart, B.H. Pollock, G. Mezei, R. Iriye, J.M. Silva, K.L. Epi, L. Kheifets, M.P. Lind, R. Kavet, Magnetic field exposure and long-term survival among children with leukemia, Brit. J. Cancer 94 (2006) 161–164.
[65] A. Huss, A. Spoerri, M. Egger, Röösli for the Swiss national cohort study, residence near power lines and mortality from neurodegenerative diseases: longitudinal study of the Swiss population, Am. J. Epidemiol. (November) (2008) (Epub ahead of print).
[66] F. Marinelli, D. La Sala, G. Cicciotti, L. Cattini, C. Trimarchi, S. Putti, A. Zamparelli, L. Giuliani, G. Tomassetti, C. Cinti, Exposure to 900 MHz electromagnetic field induces an unbalance between pro-apoptotic and pro-survival signals in T-lymphoblastoid leukemia CCRF-CEM cells, J. Cell Physiol. 198 (2) (2004) 324–332.
[67] P. Michelozzi, C. Ancona, D. Fusco, F. Forastiere, C.A. Perucci, Risk of leukemia and residence near a radio transmitter in Italy, Epidemiology 9 (Suppl.) (1998) 354.
[68] M. Repacholi, et al., Lymphomas in Eμ-Pim1 transgenic mice exposed to pulsed 900 MHz electromagnetic fields, Radiat. Res. 147 (1997) 31–40.
[69] A. Stang, et al., The possible role of radiofrequency radiation in the development of uveal melanoma, Epidemiology 12 (1) (2001) 7–12.
[70] M. Blank (2007). Section 7, pp. 1–40. Evidence for Stress Response (Stress Proteins). In BioInitiative Report: A Scientific Perspective on Health Risk of Electromagnetic Fields. Published Online 31August 2007, http://www.bioinitiative.org/report/index.htm.
[71] C. Daniells, I. Duce, D. Thomas, P. Sewell, J. Tattersall, D. de Pomerai, Transgenic nematodes as biomonitors of microwave-induced stress, Mutat. Res. 399 (1998) 55–64.
[72] D. de Pomerai, et al., Non-thermal heat-shock response to microwaves, Nature 405 (2000) 417–418.
[73] S. Kwee, et al., The biological effects of microwave radiation, in: Proceedings of the Second World Congress for Electricity and Magnetism in Biology and Medicine, Bologna, Italy, June, 1997.
[74] S. Kwee, et al., Changes in cellular protiens due to environmental non-ionizing radiation. I. Heat-shock proteins, Electro Magnetobiol. 20 (2001) 141–152.
[75] D. Leszczynski, S. Oenväärä, J. Reivinen, R. Kuokka, Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: molecular mechanism for cancer- and blood–brain barrier-related effects, Differentiation 70 (2002) 120–129.
[76] D. Leszczynski, R. Nylund, S. Joenvaara, J. Reivinen, Applicability of discovery science approach to determine biological effects of mobile phone radiation, Proteomics 4 (2) (2004) 426–431.
[77] S. Lixia, Y. Ke, W. Kaijun, L. Dequiang, H. Huajun, G. Xiangwei, W. Baohong, Z. Wei, L. Jianling, W. Wei, Effects of 1.8 GHz

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radiofrequency field on DNA damage and expression of heat shock protein 70 in human lens epithelial cells, Mutat. Res. (2006), doi:10.1016/j.mrfmmm.2006.08.010.

[78] M. Simko, C. Hartwig, M. Lantow, M. Lupke, M.O. Mattsson, Q. Rahman, J. Rollwitz, Hsp 70 expression and free radical release after exposure to non-thermal radiofrequency electromagnetic fields and ultrafine particles in human Mono Mac 6 cells, Toxicol. Lett. 161 (2006) 73–82 (Elsevier Science Direct).

[79] S. Velizarov, The effects of radiofrequency fields on cell proliferation are non-thermal, Bioelectrochem. Bioenerg. 48 (1999) 177–180.

[80] D. Weisbrot, H. Lin, L. Ye, M. Blank, R. Goodman, Effects of mobile phone radiation on reproduction and development in *Drosophila melanogaster*, J. Cell Biochem. 89 (1) (2003) 48–55.

[81] T. Olivares-Banuelos, L. Navarro, A. Gonzalez, R. Drucker-Colin, Differentiation of chromaffin cells elicited by ELF MF modifies gene expression pattern, Cell Biol. Int. 28 (2004) 273–279.

[82] R. Zhao, S. Zhang, Z. Xu, L. Ju, D. Lu, G. Yao, Studying gene expression profile of rat neuron exposed to 1800 MHz radiofrequency electromagnetic fields with cDNA microassay, Toxicology 235 (2007) 167–175.

[83] A. Karinen, S. Heinavaara, R. Nylund, D. Leszczynski, Mobile phone radiation might alter protein expression in human skin, BMC Genomics 9 (2008) 77, doi:10.1186/1471-2164-9-77.

[84] J. Vanderstraeten, L. Verschaeve, Gene and protein expression following exposure to radiofrequency fields from mobile phones, Environ. Health Persp. 116 (2008) 1131–1135.

[85] G. Abdel-Rassoul, O.A. El-Fateh, M.A. Salem, A. Michael, F. Farahat, M. El-Batanouny, E. Salem, Neurobehavioral effects among inhabitants around mobile phone base stations, Neurotoxicology 28 (2007) 434–440.

[86] P. Acherman, Exposure to pulsed high-frequency electromagnetic field during waking affects human sleep EEG, Neuroreport 11 (15) (2000) 3321–3325.

[87] E.S. Altpeter, T.H. Krebs, Study on health effects of the shortwave transmitter station of Schwarzenburg, Bern, Switzerland, University of Bern BEW Publications Study No. 56, The Federal Office of Energy, 1995.

[88] A.A. Borbely, et al., Pulsed high-frequency electromagnetic field affects human sleep and sleep electroencephalogram, Neurosci. Lett. 275 (3) (1999) 207–210.

[89] R. Huber, T. Graf, K.A. Cote, L. Wittmann, E. Gallmann, D. Matter, J. Schuderer, N. Kuster, A.A. Borbely, P. Achermann, Exposure to pulsed high-frequency electromagnetic field during waking affects human sleep EEG, Neuroreport 11 (15) (2000) 3321–3325.

[90] K. Mann, Effects of pulsed high-frequency electromagnetic fields on human sleep, Neuropsychobiology 33 (1996) 41–47.

[91] G. Oberfeld, The microwave syndrome—further aspects of a Spanish study, in: Proceedings of the Third International Workshop on Bioelectromagnetic Effects of Electromagnetic Fields, Kos, Greece, 2004.

[92] R. Santini, M. Seigne, L. Bonhomme-Faivre, S. Bouffet, E. Defrasne, M. Sage, Symptoms experienced by users of digital cellular phones: a pilot study in a French engineering school, Pathol. Biol. (Paris) 49 (3) (2001) 222–226.

[93] R. Santini, P. Santini, P. Le Ruz, J.M. Danze, M. Seigne, Survey study of people living in the vicinity of cellular phone base stations, Electromag. Biol. Med. 22 (2003) 41–49.

[94] TNO Physics and Electronics Laboratory, The Netherlands, Effects of Global Communication System Radio-frequency Fields on Well-being and Cognitive Functions of Human Beings With and Without Subjective Complaints, Netherlands Organization for Applied Scientific Research (2003), pp. 1–63.

[95] E.S. Altpeter, T.H. Krebs, Study on health effects of the shortwave transmitter station of Schwarzenburg, Bern, Switzerland, University of Bern BEW Publications Study No. 56, The Federal Office of Energy, Switzerland, 1995.

[96] S.E. Chia, Prevalence of headache among handheld cellular telephone users in Singapore: a community study, Environ. Health Persp. 108 (11) (2000) 1059–1062.

[97] H. Chiang, et al., Health effects of environmental electromagnetic fields, J. Bioelectr. 8 (1989) 127–131.

[98] H. D'Costa, et al., Human brain wave activity during exposure to radiofrequency field emissions from mobile phones, Aust. Phys. Eng. Sci. Med. 26 (4) (2003).

[99] H.P. Hutter, H. Moshammer, P. Wallner, M. Kundi, Subjective symptoms, sleeping problems and cognitive performance in subjects living near mobile phone base stations, Occup. Env. Med. 63 (2006) 307–313.

[100] M. Koivisto, et al., Effects of 902 MHz electromagnetic field emitted by cellular telephones on response times in humans, Neuroreport 11 (2000) 413–415.

[101] M. Koivisto, et al., The effects of electromagnetic field emitted by GSM phones on working memory, Neuroreport 11 (2002) 1641–1643.

[102] A.A. Kolodynski, V.V. Kolodynska, Motor and psychological functions of school children living in the area of the Skrunda radio location station in Latvia, Sci. Total Environ. 180 (1996) 87–93.

[103] C.M. Krause, L. Sillanmaki, M. Koivisto, A. Haggqvist, C. Saarela, A. Revonsuo, M. Laine, H. Hamalainen, Effects of electromagnetic field emitted by cellular phones on the EEG during a memory task, Neuroreport 11 (4) (2000) 761–764.

[104] C.M. Krause, L. Sillanmaki, M. Koivisto, A. Haggqvist, C. Saarela, A. Revonsuo, M. Laine, H. Hamalainen, Effects of electromagnetic fields emitted by cellular phones on the electroencephalogram during a visual working memory task, Int. J. Radiat. Biol. 76 (12) (2000) 1659–1667.

[105] J. Lass, et al., Effects of 7 Hz-modulated 450 MHz electromagnetic radiation on human performance in visual memory tasks, Int. J. Radiat. Biol. 73 (10) (2002) 937–944.

[106] A.A. Marino, E. Nilsen, C. Frilot, Nonlinear changes in brain electrical activity due to cell phone radiation, Bioelectromagnetics 24 (5) (2003) 339–346.

[107] G. Oberfeld, et al., The microwave syndrome—further aspects of a Spanish study, in: Proceedings of the Third International Workshop on Bioelectromagnetic Effects of Electromagnetic Fields, Kos, Greece, 2004.

[108] A. Preece, et al., Effect of a 915-MHz simulated mobile phone signal on c function in man, Int. J. Radiat. Biol. 75 (1999) 447–456.

[109] S.J. Regel, S. Negovetic, M. Roosli, V. Berdinas, J. Schuderer, A. Huss, U. Lott, N. Kuster, P. Achermann, UMTS base station-like exposure, well-being and cognitive performance, Environ. Health Persp. 114 (2006) 1270–1275.

[110] S. Eltiti, D. Wallace, A. Ridgewell, K. Zougkou, R. Russo, F. Sepulveda, D. Mirshekar-Syahkal, P. Rasor, R. Deeble, E. Fox, Does short-term exposure to mobile phone base station signals increase symptoms in individuals who report sensitivity to electromagnetic fields? A double-blind randomized provocation study, Environ. Health Persp. 115 (2007) 1603–1608.

[111] E.F. Pace-Schott, J.A. Hobson, The neurobiology of sleep: genetics, cellular physiology and subcortical networks, Nat. Rev. Neurosci. 3 (2002) 591–605.

[112] J.B. Burch, J.S. Reif, C.W. Noonan, T. Ichinose, A.M. Bachand, T.L. Koleber, M.G. Yost, Melatonin metabolite excretion among cellular telephone users, Int. J. Radiat. Biol. 78 (2002) 1029–1036.

[113] M.L. Clark, J.B. Burch, M.G. Yost, Y. Zhai, A.M. Bachand, C.T. Fitzpatrick, J. Ramaprasad, L.A. Cragin, J.S. Reif, Biomonitoring of estrogen and melatonin metabolites among women residing near radio and television broadcasting transmitters, J. Occup. Environ. Med. 49 (2007) 1149–1156.

[114] L.M. Wang, N.A. Suthana, D. Chaudhury, D.R. Weaver, C.S. Colwell, Melatonin inhibits hippocampal long-term potentiation, Eur. J. Neurosci. 22 (2005) 2231–2237.

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[115] M. Ozcan, B. Yilmaz, D.O. Carpenter, Effects of melatonin on synaptic transmission and long term potentiation in two areas of mouse hippocampus, Brain Res. 1111 (2006) 90–94.
[116] R.J. Reiter, L. Tang, J.J. Garcia, A. Munoz-Hoyos, Pharmacological actions of melatonin in oxygen radical pathophysiology, Life Sci. 60 (1997) 2255–2271.
[117] C.W. Noonan, J.S. Reif, J.B. Burch, T.Y. Ichinose, M.G. Yost, K. Magnusson, Relationship between amyloid beta protein and melatonin metabolite in a study of electric utility workers, J. Occup. Environ. Med. 44 (2002) 769–775.
[118] L.G. Salford, A.E. Brun, et al., Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones, Environ. Health Persp. 111 (2003) 881–883.
[119] J.L. Eberhardt, B.R.R. Persson, A.E. Brun, L.G. Salford, L.O.G. Malmgren, Blood–brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phones, Electromagn. Biol. Med. 27 (2008) 215–229. doi:10.1080_1536370802344037.
[120] L.G. Salford, et al., Permeability of the blood brain barrier induced by 915 MHz electromagnetic radiation continuous wave and modulated at 8, 16, 50 and 200 Hz, Microsc. Res. Tech. 27 (1994) 535–542.
[121] A. Schirmacher, Electromagnetic fields (1.8 GHz) increase the permeability of sucrose of the blood–brain barrier in vitro, Bioelectromagnetics 21 (2000) 338–345.
[122] Y. Hamnerius, Microwave exposure from mobile phones and base stations in Sweden, in: Proceedings of the International Conference on Cell Tower Siting, sponsored by the University of Vienna & Land-Salzburg, Salzburg, Austria, June 7–8, 2000.
[123] E.D. Mantiply, Summary of measured radiofrequency electric and magnetic fields (10 kHz–30 GHz) in the general and work environment, Bioelectromagnetics 18 (1997) 563–577.
[124] Sage Associates, 2004. An Overview of Low-intensity radiofrequency/microwave radiation studies relevant to wireless communications and data, Bioelectromagnetics Society Annual Meeting, Washington DC, June, 2004.
[125] C. Sage, O. Johansson, S.A. Sage, Personal digital assistant (PDA) cell phone units produce elevated extremely-low frequency electromagnetic field emissions, Bioelectromagnetics 28 (7) (2007) 581–582.
[126] C. Sage, O. Johansson, Response to comment on personal digital assistant (PDA) cell phone units produce elevated extremely-low frequency electromagnetic field emissions, Bioelectromagnetics (July) (2007), 17654541.
[127] C. Sage, O. Johansson, Response to comment on measuring ELF fields produced by mobile phones and personal digital assistants (PDAs), Bioelectromagnetics (July) (2007), 17654536.
[128] M. Tuor, S. Ebert, J. Schuderer, N. Kuster, Assessment of ELF magnetic fields from five mobile handsets, in: ITIS Foundation, Conference Presentation, Monte Verita, 2005.
[129] T. Linde, K.H. Mild, Measurement of low frequency magnetic fields from digital cellular telephones, Bioelectromagnetics 18 (1997) 184–186 (Brief communication).
[130] B. Armstrong, G. Theriault, P. Guenel, J. Deadman, M. Goldberg, P. Heroux, Association between exposure to pulsed electromagnetic fields and cancer in electrical utility workers in Ontario and Quebec, Canada, and France 1970–1989, Am. J. Epidemiol. 140 (1994) 805–820.
[131] G.M. Lee, R.R. Neutra, L. Hristova, M. Yost, R.A. Hiatt, A nested case–control study of residential and personal magnetic field measures and miscarriages, Epidemiology 13 (1) (2002) 21–31.
[132] K.D. Li, R. Oudouli, S. Wi, T. Janevic, I. Golditch, T.D. Bracken, R. Senior, R. Rankin, R. Iriye, A population-based prospective cohort study of personal exposure to magnetic fields during pregnancy and the risk of spontaneous abortion, Epidemiology 13 (2002) 9–20.
[133] G. Theriault, M. Goldberg, A.B. Miller, B. Armstrong, P. Guenel, J. Deadman, E. Imbernon, T. To, A. Chevalier, D. Cyr, C. Wall, Cancer risks associated with occupational exposure to magnetic fields among utility workers in Ontario and Quebec, Canada and France: 1970–1989, Am. J. Epidemiol. 139 (1994) 550–572.
[134] P. Michelozzi, A. Capon, U. Kirchmayer, F. Forastiere, A. Biggeri, A. Barca, C.A. Perucci, Adult and childhood leukemia near a high-power radio station in Rome, Italy, Am. J. Epidemiol. 155 (2002) 1096–1103.
[135] M. Ha, H. Im, M. Lee, H.J. Kim, B.C. Kim, Y.M. Gimm, J.K. Pack, Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer, Am. J. Epidemiol. 166 (2007) 270–279.
[136] C. Sage, D.O. Carpenter (Eds.), BioInitiative Working Group BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF), 2007. www.bioinitiative.org.;
C. Blackman, H. Lai, Chapters 6 and 14 of the BioInitiative Report, 2007.
[137] A. Chiabrera, B. Bianco, E. Moggia, J.J. Kaufman, Bioelectromagnetics 21 (4) (2000) 312–324.
[138] D.J. Panagopoulos, L.H. Margaritis, in: A.C. Harper, R.V. Buress (Eds.), Mobile Telephony Radiation Effects on Living Organisms, 2008, pp. 107–149. ISBN 978:1-60456-436-5.
[139] W.R. Adey, in: P.J. Rosch, M.S. Markov (Eds.), Potential Therapeutic Applications of Nonthermal Electromagnetic Fields: Ensemble Organization of Cells in Tissue as a Factor in Biological Field Sensing, Bioelectromagnetic Medicine, 2004, pp. 1–16.
[140] S. Engstrom, in: P.J. Rosch, M.S. Markov (Eds.), Magnetic Field Generation and Dosimetry, Bioelectromagnetic Medicine, 2004, pp. 39–50.
[141] A. Pilla, in: F.S. Barnes, B. Greenebaum, (Eds.), Mechanisms and Therapeutic Applications of Time-varying and Static Magnetic Fields in Biological and Medical Aspects of Electromagnetic Fields, third edition, 2007, pp. 351–412.
[142] M. Blank, R. Goodman, Initial interactions in electromagnetic field-induced biosynthesis, J. Cell. Physiol. 199 (2004) 359–363.
[143] M. Blank, R. Goodman, A biological guide for electromagnetic safety: the stress response electromagnetic initiation of transcription at specific DNA sites, Bioelectromagnetics 25 (2004) 642–646.
[144] M. Blank, BEMS Soc. Newslett. (January–February) (2008) 6–7.
[145] G. Lotz, Letter from Greg Lotz, PhD, Chief Physical Agents Effects Branch, Division of Biomedical and Behavioral Science, National Institute of Occupational Safety and Health to Richard Tell, Chair, IEEE SCC28 (SC4) Risk Assessment Work Group, June 17, 1999.
[146] P. Grandjean, Implications of the precautionary principle for primary prevention and research, Am. Rev. Public Health 25 (2004) 199–223.
[147] D. Davis, The Secret History of the War on Cancer, Basic Books, 2008.
[148] R. Proctor, Cancer Wars, Harper Collins Publishers, 1995.
[149] European Environmental Agency, Late Lessons from Early Warnings. The Precautionary Principle 1896–2000. Copenhagen, Denmark, 2001.
[150] P. Landrigan, How much do chemicals affect our health? Discover Mag. (2008).
[151] California Air Resources Board, Appendix III Proposed Identification of Environmental Tobacco Smoke as a Toxic Air Contaminant. Part B—Health Effects, 2005.

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Public Comments on Developing an Unified Intercarrier Compensation:========

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See attached file(s)

FCC 09-31 Notice of Inquiry GN Docket No. 09-51 - Broadband Plan for Our Future

EXHIBIT TABLE to accompany the Comment of The EMR Policy Institute June 7, 2009

No.	Name		City State	Info	TYPE
1	Litovitz, Theodore	PhD, Physics	Catholic University	Presentation used at Congressional Staff Briefing	
2				*Pathophysiology*, March 2009	Journal articles
3	Hillman, Donald	PhD Animal Science	East Lansing MI	Analysis of RF in home	Affidavit
4	Tully, Lisa	PhD Toxicology and Pharmacology	Boulder CO	Developing EHS test	Affidavit
5	Schou, John	PhD Agronomy Researcher	Cedar Falls IA	EHS symptoms wife had to move to WV	Affidavit
6	Schou, Diane	PhD Industrial Technology	Green Bank WV	Industrial Technology Severe EHS had to move to WV husband in IA	Affidavit
7	Bruno, William	PhD, Physics Researched at Los Alamos	Santa FE NM	Severe symptoms Comment in NAS record	Affidavit
8	Dauble, Janet	Non-profit organization	Frazier CA	MCS EHS support group founder increase in 10 yrs	Affidavit
9	Carney, Deborah	JD. BA-Human Biology	Golden CO	EMRPI VP CARE counsel Research subject	Affidavit
10	Fox, Nicols	Journalist	Renick WV	Documents severe EHS moved from ME to WV	Affidavit
11	Kleiber, Daniel	Farmer beekeeper	Waterloo WI	Type 1 diabetic documented insulin effects	Affidavit
12	Kleiber, Catherine	BA in biological science	Waterloo WI	Severe microwave sickness Dirty power and RF reactions Young children react as well	Affidavit
13	Savarin, Evelyn		Hampton NH	EHS from education exposure Documents with own meters	Affidavit

13B	Gherzi, Alex	Savarin's landlord	Hampton NH	Landlord to Savarin child can now sleep with WiFi off	Affidavit
14	Hurston, Ronald	M.D.	Wayland, MA	"It invites potentially tragic public health consequences."	Affidavit
15	Patton, Margaret	2-time cancer survivor	Wayland MA	Close to tower long legal battles to enforce zoning	Affidavit
16	Ide, Judith	Concerned citizen	Wayland, MA	Close to tower long legal battles to enforce bylaw	Affidavit
17	Lettieri, Linda	Liver cancer survivor	Fishkill NY	Had to leave job because cell tower was erected there	Affidavit
18	Pape, Beverly	Breast cancer	Dallas TX	Still in treatment for cancer EHS headaches cognition	Affidavit
19	Kayda, Valetta	2 brain tumors	Kelso WA	Tumor treatment caused EHS Moved 3 times already	Affidavit
20	Singer, Katie	EHS Reproductive health educator	Santa Fe, NM	Written 2 books on reproductive health has severe symptoms herself	Affidavit
21	DiGennaro JoTina	Substitute teacher Husband has prostate cancer	Bayville NY	Water tower antennas 50 ft from school deed covenant violated	Affidavit
22	Perrin, Madeleine	Mother of 2 young kids	Bayville NY	Can't get kids into another school tower 50ft away	Affidavit
23	Rollans, Marian & James	Farmers 39 years	Mt. Ulla NC	Fighting broadcast towers 3 cell towers close by EHS symptoms	Affidavit
24	Webster, Betsy	Concerned parent	Mt. Ulla NC	Fighting broadcast proposal 15 towers already nearby	
25	Davis, Ruth	EHS sufferer	Ouray CO	Notarized version to follow	Affidavit

26	Hinson, Katherine	Mother 15yr 13yr boys EHS	Plymouth VT	Left GA for boys' health	Affidavit
27	Russo, Kristin	Mother of 3 kids	Burlington MA	Water tower antenna at school Moved recently to avoid	Affidavit
28	Clark, Gayle	mother 14 yr old son	Sedgwick KS	WiFi at school and work Tower proposed near home	Affidavit
29	Hackett, Lucy	EHS Injury began in college	South Bend, IN	Difficulty finishing degree Antennas close to home and family now	Affidavit
30	Danner, Ruth		Juneau AK	2 WiMax towers proposed 4 co-locators proposed at church with daycare	Affidavit
31	Bubnis, Michelle	EHS neighbor's WiFi	Austin TX	many antennas One at church can no longer attend	Affidavit
32	Zack, Corina	Concerned citizen	Arlington Heights, IL	Antenna in church across the street from home	Affidavit
33	Reilly, Sarah	MCS EHS	Fairfax, CA	Has to move often 2003 WiFi brought it on	Affidavit
34	Frumberg, Maria	EHS Dr. Rea :letter	Plano, TX	Had to drop wireless TV access Letter from city shows no concern about WiFi	Affidavit
35	Ordogne, Kimberly	EHS	Plano, TX	Had to leave home Citywide WiFI No sympathy from city	Affidavit
36	Feudale, Elizabeth	MCS EHS Allergies immune problems	Allentown, PA	Cell towers nearby cannot tolerate home electronics	Affidavit
37	Olson, Veronica	Concerned parent	Plano, Texas	Concerned about citywide WiFi exposure to children	Affidavit
38	Hillman, Howard	Concerned citizen	Plano, Texas	Concerned about citywide WiFi exposure to children and immune-compromised people	Affidavit
39	Flynn, Angela	EHS came at job training near	Bethseda, MD	Moved to ease exposure EHS symptoms are Sleep muscle aches cognition	Affidavit

		antennas			
40	Lizik, Kyrie	EHS	Washington County WI	Smart meter aggravates Cannot use library – WiFi	Affidavit
41	Barris, Elizabeth	EHS documentary film maker	Santa Monica CA	Airport exposure an issue Must travel for work	Affidavit
42	Avola, JeanMarie	Concerned parent	Stoneham MA	Cell towers and WiFi in and near children's schools	Affidavit
43	Kelley, Elizabeth	Bioelectromagnetics Society member	Tucson ARIZ	Cell towers and WiFi in neighborhood Son's school has WiFi	Affidavit
44	Boca Raton, Florida	States of Colorado and Connecticut, Los Angeles County	Portland, Oregon Los Angeles public school district	**US states and municipalities are calling for revision of Section 704**	Proclamations and Resolutions
45	National Academies of Science	January 2008 Report		*Identification of Research Needs Relating to Potential Biological or Adverse Health Effects of Wireless Communication Devices* (NAS Report)	Research base inadequate for today's exposures
46	FDA nominates RF	To National Toxicology Program		Radiofrequency Radiation Emissions of Wireless Communication Devices	Research does not address typical RF exposures
47		NTP 2005 Fact Sheet on RF research	US federal government	Underscores inadequacy of research upon which US RF safety limits are based	
48	Carpenter, MD, Sage, Cindy	***The BioInitiative Report***	www.bioinitiative.org	*A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*	On-line meta-analysis of EMR research
49 & 50	Carpenter and Sage	***Reviews in Environmental Health***	Peer-reviewed Scientific journal	*"Setting Prudent Health Policy for Electromagnetic Exposures"*	Journal article
51	Horst Eger, Klaus Uwe Hagen, Birgitt Lucas, Peter Vogel, and Helmut Voit	*Umwelt·Medizin·Gesell-schaft* 17,4 2004,	Research requested by German federal government	"The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer"	Peer-reviewed Journal article
52	Carpenter	Amicus brief and	Review research	warn of the potential health consequences for	

	Olden Grigoriev Havas	statements on RF radiation and school children	and existing EMR safety limits	many students and staff if wireless technologies are deployed in their workplaces.	

To: **Michael Copps, Acting FCC Chairman**

Subject: **Comment for Notice of Inquiry - A National Broadband Policy for our Future, GN Docket No. 09-51**

From: **Donald Hillman, East Lansing, Michigan**

AFFIDAVIT OF DR. DONALD HILLMAN

Donald Hillman, having been duly sworn, states as follows:

1. **I am a Professor Emeritus at Michigan State University.**
2. **I hold a Ph.D. in the Michigan State University Department of Animal Science.**
3. **My career experience includes 60 years of work in the area of dairy animal science.**
4. **I have studied the relationship of step potential electric current to milk production on dairy farms in Michigan, Wisconsin, Minnesota and Virginia since 1982.**
5. **I learned that electric and magnetic fields (EMF) inhibited milk production of dairy cattle as reported by Appleman et al. in USDA-ARS Publication 696, 1991, section-page 3-16 and 3-17.**
6. **Further, electropathic stress proliferated impairment of animal health resulting in financial losses to dairymen averaging $2,629 per cow per year during the period of exposure to uncontrolled electricity commonly called stray voltage.**
7. **Further, the decreases of milk production on low-voltage farms were positively correlated with powerline harmonic and radiofrequency currents.**
8. **The voltages that were causing damage to dairy cattle were below the 1-Volt threshold erroneously considered safe by utility experts.**
9. **Secondly, I measured electric and magnetic fields: milligauss, current, and frequencies of voltage from the neutral-to-ground wire of a Nextel cellular telephone**

EXHIBIT 3

relay station mounted on and under the East Lansing City water tank, as permitted by the Federal Communications Act of 1996.

10. **Radiofrequency currents were recorded from the ground wire that was bonded to the city water system and transferred onto water pipes bonded to the ground wire in our home and the homes of ten neighbors.**
11. **Utility engineers from Lansing Board of Water and Light confirmed my measurements, recorded the magnetic field radiated from the ground wire into the living room of our home for 24-hour periods on two occasions.**
12. **The magnetic field range from 0-320 mG and averaged 97 milliGauss (standard deviation 37.9 mG).**
13. **During five test experiments, while I was sitting on the sofa in our living room, my heart rate and blood pressure increased linearly as the magnetic field (mG) in the room, and radiated current (amperes) increased as recorded with ammeter from my body acting as antenna.**
14. **Our findings concur with reports of radiated electrical energy resulting in cardiovascular effects on humans and animals found in some 25 credible bioelectric and medical journals. A full report is available at your request.**
15. **The Federal Communications Act of 1996 and local promoters of the cell-phone tower failed to disclose that EMF generated by AC/DC switch mode devices from cellular telephone towers appear on the neutral wires and radiate into homes, schools, and workplaces .**

16. **Four residents living within 100 meters of the cell-phone tower in our neighborhood have arrhythmic hearts, two have pacemakers, and one has a defibrillator attached to his heart, while another suffers from nonHodgkins lymphoma; not coincidental.**
17. **Electromagnetic contamination of the living environment from electronic devices may account for the increased hypertension of citizens at every age from 20-85 years, with unknown cause as reported by the American Heart Association.**
18. **Further investigations must consider neuroendocrine effects of EMF on secretions of all glands that control physiological functions of human and animal bodies.**
19. **The permeability of biological tissue, (e.g. cattle and humans) to magnetic fields is essentially the same as air; therefore, assumptions of resistance based on specific absorption rate (SAR) of a gram of fat have little relevance for estimating the effects of electromagnetic fields on the health of living specimen.**
20. **I recommend that the FCC reevaluate effects of exposure to uncontrolled radiofrequency currents from all sources on human and animal health before promoting or permitting any further wireless EMF saturation of the living environment.**
21. **Federal Communication Commissioners must weigh the cost of radiofrequency electropathic stress to human suffering, additional medical and hospital insurance cost, and damage to the animal industry economy versus further uncontrolled expansion of Broadband until the financially vested interests have proven the safety of the product they wish to impose on an unsuspecting public.**
22. **I personally observed and was involved in such Tests and Measurements as set forth above.**

If called upon to testify, I could testify to the foregoing based on my personal knowledge.

FURTHER AFFIANT SAYETH NOT

Dated: June 4, **2009**

Donald Hillman
Donald Hillman, Ph.D.

STATE OF MICHIGAN)
) ss.
COUNTY OF INGHAM)

On this 4 **day of** June, **2009, Dr. Donald Hillman personally appeared and acknowledged that he has read the foregoing affidavit and acknowledges the same is true.**

ANDREA GARLITZ
NOTARY PUBLIC - STATE OF MICHIGAN
COUNTY OF EATON
My Commission expires March 31, 2014
Acting in the County of Ingham

Notary Public

My commission expires on March 31st, 2014

304 923 0022

AFFIDAVIT OF LISA TULLY

State of Colorado]
] ss.
County of Boulder]

LISA TULLY being duly sworn deposes and says:

1. My name is Lisa Tully. I live at 27 Arrowleaf Ct., Boulder, CO 80304

2. I have a background in medical research with a PhD in Pharmacology and Toxicology from the Indiana School of Medicine. I am currently involved in developing a diagnostic test for electrohypersensitivity. It is such a new disease there is no test for it. More and more people are becoming sick, some are being severely debilitated.

3. I have reviewed some of the literature on the health problems associated with radio and microwave frequencies, which clearly demonstrates harmful biological effects at much lower exposures than the FCC standards for exposur. The FCC's current RF exposure guidelines are inadequate in light of the findings of current science.

3. Furthermore, because of the number of cell service carriers operating in our area, there are many overlapping signals and standards exist only for single source radiation, which does not exist. Therefore, individuals are being exposed to much higher levels.

4. I am very concerned about health effects of long-term continuous exposure to one or many signals, which has not been studied. We are in the midst of a frightening experiment.

5. I do not want to be exposed to the harmful frequencies produced by the government-sanctioned rollout of new technologies with insufficient safety standards.

6. We need stronger FCC standards and the enforcement of such standards to prevent be health hazards of this low level radiation over time.

7. I have a right to be safe in my home and workplace, and I have a right to current safety standards based on current science. These standards are not based on harmful biological effects.

8. I understand that the EMR Policy Institute is preparing comment to submit in the current Federal Communications Commission proceeding to develop the policy for providing high-speed internet service throughout the country - FCC 09-31, A National Broadband Plan for Our Future.

EXHIBIT 4

9. The undersigned hereby designate The EMR Policy Institute to speak on my behalf on this FCC proceeding for the purpose of defending our rights to be safe in our own home, in our schools and our workplaces and neighborhoods from the invasion into our home, schools and workplaces of signals that may cause harm to us.

16. I ask that the FCC accept this affidavit and the attached exhibits into evidence for consideration under FCC 09-31, A National Broadband Plan for Our Future, as it is material evidence of the existence of signals to which I am subject, yet without proper standards based on current science.

Lisa Tully

Sworn to before me

This 2 day of June, 2009

Notary Public

JARED S ROCHON
Notary Public
State of Colorado

expires: 08-28-2012

AFFIDAVIT OF JOHN BERTEL SCHOU

State of Iowa]

] ss.

County of Black Hawk]

JOHN BERTEL SCHOU being duly sworn deposes and says:

1. My name is John Bertel Schou. I currently live at 6117 and 6621 West Ridgeway Avenue in Cedar Falls, Iowa 50613 with the latter being the farm address. My mailing address is P.O. Box 249, Cedar Falls, Iowa 50613.

2. I have been in Cedar Falls, Iowa for 29 years, prior to which I lived in St. Louis, Missouri.

3. My home is at 6117 West Ridgeway Avenue, Cedar Falls, Iowa. Our (my wife and myself) farm/business is located at 6621 West Ridgeway Avenue, Cedar Falls, Iowa where I both live and work and do research on the environment and especially on crop responses to treatments imposed on the soil and crops.

4. I am a research scientist with a doctorate in crops and soils known as agronomy from Michigan State University in or about 1973 and subsequently worked on a postdoctorate at Ohio State University at Wooster, Ohio for two years prior to working with Monsanto for five years in St. Louis, Missouri. I was a senior research scientist at Monsanto with field research on plant growth regulators at the corporate office in Creve Couer, Missouri.

5. While at Ohio State University my research was in the lab and field and dealt with carbon dioxide effects and plant growth regulator effects on soybeans. My doctorate work at Michigan State had been on the effects of several fertilizers on leaf and soil nitrate levels and included work with N15 materials that were analyzed on gas chromatographs and mass spectrometers.

6. I was in the medical corps with the United States Army and was trained at Fort Sam Houston, Texas and later taught in the Army Reserves Chemical- Biological-Radiological courses in Michigan and elsewhere.

7. Research conducted at ACRES – agricultural custom research and environmental studies has involved radiolabel work and testing for yields of crops as influenced by various fertilizer, herbicide, and growth regulator treatments including tillage and planting systems.

EXHIBIT 5

8. Since the realization that my wife Diane was able to detect and was influenced by radio frequencies even below detectable as well as detectable limits on meters we own and other meters we have worked with I have been aware of radio frequencies and electrical fields in our environment and studied their origins.

9. My personal symptoms which I am attributing to changes in the environment especially radio frequencies and electrical fields or similar are based on epidemiological approaches which are associating symptoms with environments. Conditions which I have and continue to associate with these conditions and for which I am working on studies to measure glucose level changes in myself. Conditions include: sleep disorder (apnea) which I have, eye floaters which come and go and especially go when out of the environments with radio frequencies, hair growth which also proliferates outside the radio frequency environments, and tintinitus (ringing in the ears) which also abates when out of higher level radio frequency environments. Measuring glucose levels in my system and especially the blood has shown higher levels around higher electrical environments.

10. I have seen Diane in a remote, low-level electrical environment in Nicaragua on the island of Ometepe where she responded with increased glucose sugar levels when close to a measured electrical field and this occurrence was repeated like five times. Her glucose sugar levels varied from 120 in low conditions to 160 in higher electrical environments. Insects also avoided these electrical fields as well. The fields were measured with meters we had and were in volts/meter square. I do not remember the readings as this was approximately four years ago while we were still new and studying the conditions she experienced.

11. I notice more frequently now the effects on AM radio in many areas where electrical fields illustrate the effects from power lines or other electrical sources.

12. It is logical from a scientist's view (my majors and minors were biochemistry and plant physiology and agronomy with approximately 60 hours of chemistry) that different people can react in many different ways as biological systems respond to low level effects of chemicals or electrical fields.

13. For safety from radio frequency fields it is recommended by me to go to buried cable and fiber optical systems which provide efficiencies, security, and protection from elements of the environment on the systems themselves.

14. I have missed living with my wife while I need to work in Iowa for an income on our research operations there and my wife needs to be protected and lives in the radio quiet zone of West Virginia. This separation for a major part of the year does affect our lives in many ways and causes hardships when we need to work together on projects and be together for social and personal companionship.

15. My concerns are that exposure levels are far too high and everyone is affected and only those with sensitized systems are showing the most visible effects now. In

other words they are the canaries in the coal mine showing the first visible symptoms of major problems for all. Scientists have warned it can be far worse than asbestos or smoking.

16. I recommend that measurements be made of intensities of electromagnetic and electrical fields and radio frequency information be made available through more use of meters and trained personnel that can associate the problems with the conditions in environments. The number and intensities of radio frequencies are increasing and pose challenges. If we as a society can help to improve people's lives the efforts are worth the investment of time and energy.

17. The proven method of removing many of the symptoms has been to remove the person from the conditions or turn off the source of the problem. This is not a welcome alternative to the communications, military, and power industries, but should be weighed in the balance of overall costs to the society. A balance should be able to be found and the effects are known to be real by all of the above groups. People who have symptoms need safe areas to retreat to and live in.

18. The FCC can and should be more proactive and do much more than sending out brochures, registering tower sites and ham radio operators, and holding meetings.

19. We understand that the EMR Policy Institute is preparing comments to submit in the current Federal Communication Commission proceeding to develop the policy for providing high-speed internet service throughout the country – FCC 09-31. A National Broadband Plan for Our Future.

20. The undersigned and all the persons in our household hereby designate The EMR Policy Institute to speak on our behalf on this FCC proceeding for the purpose of defending our rights to be safe in our own home, in our schools and in our workplaces and neighborhoods from the invasion into our home, schools and workplaces of signals that may cause harm to us, because the FCC's current RF exposure guidelines are inadequate in light of the findings of current science.

21. I ask that the FCC accept this affidavit and any attached exhibits into evidence for consideration under FCC 09-31, A National Broadband Plan for Our Future, as it is material evidence of the existence of signals to which my family and I are subject, yet without proper standards based on current science.

John Bertel Schou

Sworn to before me
This 4 day of June, 2009

Notary Public

ANGELA J. FARLEY
NOTARIAL SEAL - STATE OF IOWA
COMMISSION NUMBER 197695
MY COMMISSION EXPIRES 8/32010

Please Do Not Reply To This Email.

Public Comments on Developing an Unified Intercarrier Compensation:========

Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Heather
Last Name: Faught
Mailing Address: 973 Troost Street
City: Roseburg
Country: United States
State or Province: OR
Postal Code: 97471
Organization Name: null

As a person with electromagnetic sensitivities, I rely heavily on the landline at my home for long phone calls. I only use my cell phone for emergencies and very short calls. These short calls on my cell phone still can give me headaches.

It is estimated that approximately 10 million people have electromagnetic sensitivities. Landlines should still be an option to those who are disabled in this way. Our quality of life depends on those who accomodate us, even if we are a minority.

Thank you for this help.

Please Do Not Reply To This Email.

Public Comments on Developing an Unified Intercarrier Compensation:========

Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Janet
Last Name: Newton
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Country: United States
State or Province: VT
Postal Code: 05658
Organization Name: EMR Policy Institute

See attached file(s)

FCC 09-31 Notice of Inquiry GN Docket No. 09-51 - Broadband Plan for Our Future

EXHIBIT TABLE to accompany the Comment of The EMR Policy Institute June 7, 2009

No.	Name		City State	Info	TYPE
1	Litovitz, Theodore	PhD, Physics	Catholic University	Presentation used at Congressional Staff Briefing	
2				*Pathophysiology*, March 2009	Journal articles
3	Hillman, Donald	PhD Animal Science	East Lansing MI	Analysis of RF in home	Affidavit
4	Tully, Lisa	PhD Toxicology and Pharmacology	Boulder CO	Developing EHS test	Affidavit
5	Schou, John	PhD Agronomy Researcher	Cedar Falls IA	EHS symptoms wife had to move to WV	Affidavit
6	Schou, Diane	PhD Industrial Technology	Green Bank WV	Industrial Technology Severe EHS had to move to WV husband in IA	Affidavit
7	Bruno, William	PhD, Physics Researched at Los Alamos	Santa FE NM	Severe symptoms Comment in NAS record	Affidavit
8	Dauble, Janet	Non-profit organization	Frazier CA	MCS EHS support group founder increase in 10 yrs	Affidavit
9	Carney, Deborah	JD. BA-Human Biology	Golden CO	EMRPI VP CARE counsel Research subject	Affidavit
10	Fox, Nicols	Journalist	Renick WV	Documents severe EHS moved from ME to WV	Affidavit
11	Kleiber, Daniel	Farmer beekeeper	Waterloo WI	Type 1 diabetic documented insulin effects	Affidavit
12	Kleiber, Catherine	BA in biological science	Waterloo WI	Severe microwave sickness Dirty power and RF reactions Young children react as well	Affidavit
13	Savarin, Evelyn		Hampton NH	EHS from education exposure Documents with own meters	Affidavit

AFFIDAVIT OF DIANE SCHOU

State of West Virginia]
] ss.
County of Pocahontas]

DIANE SCHOU being duly sworn deposes and says:

1. My name is Diane Schou. I currently live at RR1, Wesley Chapel Road #58, Green Bank, West Virginia. My mailing address is P.O. Box 99, Green Bank, West Virginia 24944-0099.

2. I have been in Green Bank, West Virginia for 2.5 years, either sleeping in my vehicle or camping in a house that is not finished.

3. My previous home was at 6117 West Ridgeway Avenue, Cedar Falls, Iowa.

4. My husband, John Bertel Schou (Bert) and I have a research farm/business located at 6621 West Ridgeway Avenue, Cedar Falls, Iowa. Inside a converted barn, we have an office.

5. My husband is a scientist (Ph.D.) and does research in the environment. I have both a Ph.D. and M.S. in Industrial Technology and a B.S. in Human Ecology.

6. I was injured by electro-magnetic radiation and thus became aware of the correlation of technological trigger sources and the unfortunate health consequences. Within nine months after a new cell tower was activated, my health deteriorated and it was linked to emissions from that cell tower. I had to leave our family farm which meant living away from my husband who still farms there. The only documented, proven, repeatable solution to regain health is no exposure. I went to remote areas. It was stressful to abandon home, career and future/dreams in order to avoid exposure. Seven years ago I would not have believed in the seriousness of electro-smog. I am now in the quiet zone in West Virginia (Stewart, 2009), another remote area, safer, but not perfect. U.S. standards are grossly outdated and do not reflect currant scientific research.

7. In 2002 cell tower (U.S. Cellular) was built about 1/3 mile from our home at 6117 West Ridgeway Avenue, which is also about 2/3 mile from our farm/office/lab at 6621 West Ridgeway Avenue. I did not like it, but I did not worry about it.

8. After the cell tower was built and activated, I became ill. By 2003 the symptoms then included rash, hair loss, wrinkled skin, changes in vision (difficulty focusing to read), fatigue, nausea, difficulty sleeping. These are the symptoms of radiation poisoning or radio-wave sickness.

EXHIBIT 6

9. When I became ill from a headache, I went to the doctor. Headaches are not normal for me.

10. My family doctor found other problems: thyroid changes and diabetes.

11. My husband and I observed and confirmed my health responses to the cell tower. We thought we discovered the cause. See [Exhibit A]. When driving home from the west, I experienced a small headache which kept growing as we continued eastward. This was unusual because I rarely got headaches and it was strange a headache started small and grew more and more painful. A sudden headache hit me when I drove home from Cedar Falls, heading south on Hudson Road, just past Union Road. Both of these headaches occurred again and again and again. I am not prone to headaches. The wallop headache occurred when I approached the top of a hill to the line-of-site to the cell tower.

12. We contacted U.S. Cellular, we thought we would get help, either the emissions turned off or directed away from us. A letter of denial was sent to us. We contacted FCC, they only sent us a brochure that was safe.

13. Changes in health appeared about nine months after the cell tower (U.S. Cellular) antennas were activated,

14. A radiation specialist deduced the headache may be warnings, the neurons/cells were either being injured or being killed. Two papers report this happening, there are many more: Firstenberg, A. (1997). Microwaving our planet: the environmental impact of the wirelss revolution (2nd Edition ed.). Mendocino, CA: Cellular Phone Taskforce. Salford, L. G., Brun, A. E., Eberhardt, J. L., Malmgren, L., & Persson, B. R. (2003). Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. Environ Health Perspect, 111(7), 881-883; discussion A408.

15. The emissions (I learned is called non-ionizing radiation) from the cell tower (U.S. Cellular) near our home may have accumulated in my body to become overexposure. At that time, I found myself sensitive to and harmed by a cell towers owned/operated by U.S. Cellular. It seemed I did not feel headaches from AT&T, Cellular One, nor Verizon. I do not know why.

16. I continued living at home, but, was becoming unable to do many things.

17. One night in 2003, things came to a crisis. I could not sleep. It was about 2 a.m., my head was hurting. The situation had become unbearable. My husband got me immediately away. I did not pack. I've never been back except for one 20-minute visit.

18. I have lived or slept in my vehicle or a hatchback since (2003 to present).

19. Since I had not prepared to be away from home, I have been without many items. It has been difficult. Try to ask your husband to find and bring your items he has

never used and probably never looked at. It has been over six years. There were some successes, but there are still many voids.

20. To escape the cell phones (especially U.S. Cellular), I went to Norway (my son was a student there and at that time American and Norwegian cell phones and carriers were different). There I learned about radiofrequency effects and to how to measure frequencies using a spectrum analyzer.

21. After a couple of months of being away, I tried to return home. I did not feel any headaches. It was thrilling to be home! Unfortunately, in maybe 20 minutes, I felt the sickest I had ever been. Rash, headache, shaking. Was this radiation sickness? I tried to visit my doctor to confirm this, but the clinic and his associates were too busy.

22. At this point of re-injury, a new symptom: headaches when others used cell phones.

23. Sadly, I cannot go home without consequences of headaches, thyroid problems, rash, from the cell tower. Even a drive-by is too much radiation.

24. My husband and I searched remote areas in my vehicle looking for a place without cell phone reception. We wanted it to be a place where Bert could sleep and yet be able to continue his profession on the research farm/business.

25. I returned to Norway with my spectrum analyzer and returned to places where I had experienced discomfort. A Faraday cage at a Norwegian research facility was demonstrated to have a leak. A location in a shopping mall had an inappropriate antenna. In the corner of a room where I had felt better, the spectrum analyzer confirmed low levels of electromagnetic radiation. One night, I had a throbbing headache and the spectrum analyzer measured pulsing frequency spikes. I could turn off the scientific instrument, but the pounding headache did not go away. I had to find protection.

26. I learned about a community in Snowflake, Arizona where there were people who were electromagnetic radiation sensitive and or multiple chemical sensitive. It was one alternative to being ill or to remaining homeless. We traveled to Arizona, looked at other areas in Missouri, Arkansas, New Mexico, and especially Socorro the Very Large Array radio telescope.

27. In Snowflake, AZ, we visited Susan Molloy. Bert started coughing up blood not long after we had arrived. We left immediately for emergency at a hospital. By the time we got to emergency, the bleeding had stopped. We continued to California, driving up a mountain, the coughing bleeding started again. A trip to Mayo Clinic emergency diagnosed a ruptured blood vessel in Bert's lung. It was possible the higher altitudes triggered it. It was recommended we stay near the clinic for a few weeks. We used this time to explore, looking for a safe place free from electromagnetic radiation.

28. Bert found a small village and a campground surrounded by mountains. The tiny population would likely discourage a cell tower. We stayed there overnight; we extended our stay to three months, then to a year, then put a deposit on a park model for me to stay permanently.

29. With me in Arizona and our research farm in Iowa, my husband's only choice was to commute this long distance.

30. When I lived in a remote village in Arizona, I enjoyed the many activities (even though I was confined to that valley).

31. Eventually I became sensitive to electrical/magnetic fields, electrical appliances (coffee makers, vacuum cleaners), fluorescent lights, DC lights, ceiling fans, refrigerators, furnace blower motors, space heaters, electric water heaters, power lines, coffee makers, speakers, electrical instruments, electrical cords, power lines, small and large transformers. I could not go for walks (power lines and peoples air conditioners), when a person in another room ran a coffee maker, it hurt. I telephoned Bert and cried in pain when aircraft flew over.

32. In less than 24 hours, I returned to Sweden and Norway once more, to escape 60 Hz fields. Both Sweden and Norway electricity use 50 Hz. I was amazed to not feel pain from a coffee maker. Two electrical things still triggered pain: refrigerators and fluorescent lights.

33. I spent 3 ½ months searching for a humane place to live. I found some cell towers and cell phones injured me. Ones that did not, four days exposure, I developed a sensitivity to. Much of the time, I lived in a hatchback. I met many electromagnetic radiation sensitive/injured people. At one point, I reacted strongly to my notebook computer, that I had kept on and running nearby. Towards the end of the three months, I began reacting 50 Hz electrical devices.

34. Doctors reports of my injury from electromagnetic radiation are enclosed. [Exhibit B]

35. Return to United States. My sensitivity to 60 Hz had lessened. I try to be careful. I do not want to get back to that extreme sensitivity again.

36. I returned to Arizona and continued house hunting. When a cell phone booster antenna was put in nearby, the radiation sickness symptoms returned.

37. To bring me closer to my husband in Iowa, a system was created where I could be in a Faraday cage (blocking radiation from the cell tower).

38. When electrical transmission lines were installed near a Faraday cage my husband and friends built for me, the electromagnetic radiation emissions penetrated the shielding. Again I had to leave and once more I was homeless.

39. I went to the radio-quiet zone in West Virginia. I am tired of being homeless. Since the research farm cannot be moved there, my husband commutes from Iowa.

40. When people (tourists, visitors) bring cell phones, the electromagnetic radiation injures me. When some vehicles drive by, I feel pain. Possibly the vehicles have cell phones (and maybe GPS tracking emissions) which is harmful to me.

41. I had lost hair on my legs, under my arms, and in my pubic area. It grew back when I moved to Green Bank, West Virginia in the radio quiet zone.

42. When I leave the radio-quiet zone to where there is one or more cell towers, I get a rash, headache, ringing in the ears, fatigue, chest pain, diarrhea

43. I enclose a newspaper article describing my condition. [Exhibit C]

44. Concern: Wi-Fi has never been properly tested for safety.

45. Fiber optics instead of wireless communication / emissions would satisfy many safety concerns.

46. Concern: Electromagnetic radiation is not contained, it is invisible, permeates through walls, is far reaching and exposure is involuntary. It goes through curtains, walls, ceilings and floors. There is increasingly no place to escape exposure. Continual, persistent exposure becomes overexposure and health deteriorates.

47. I do not know of anyone who ***chooses*** to be exposed to electromagnetic radiation.

48. Concern: Use of technological devices has immediate gratification.

49. Concern: Please provide access to meters that can log and meters that can report (plus the necessary antennas) to us all frequencies and amplitudes (power levels). A correlation needs to be available between the immediate gratification of technological devices and immediate danger of invisible electromagnetic radiation.

50. Concern: Installing nationwide wireless broadband and broadband over powerlines has to be halted.

51. Concern: current Wi-Fi needs to be turned off.

52. Concern: Federal regulations should not mandate technologies while prohibiting the raising of health concerns. Example, if you were a manufacturer of a car and you knew the auto industry couldn't be sued, would that be right for the public? Example, if you were in the food industry and you knew you could not be sued for health reasons, how careful would the food industry be? In the advancement of technology, if you were an honest and helpful company, would

you even consider a bill with section 704 in the telecommunications act denying the right to health and wellbeing? Please rescind this bill. To force change while denying assurance of safety is wrong.

53. Electromagnetic radiation emissions are completely un-natural and present exposures never before experienced by life (animal or plant) on this planet. There is every reason to comprehend they are harmful. Please view and listen to:

    Belpomme, D., Adlkofer, F., Hardell, L., & Johansson, O. (2009). Electromagnetic fields on our health, Technologies sans fil: un nouvel enjeu sanitaire <http://www.robindestoits.org/Colloque-au-SENAT-Electro-hypersensbilite-EHS-Appel-des-scientifiques-europeens-23-03-2009_a777.html>: Robin Des-Toits: Colloque au SENAT - Electro-hypersensbilité (EHS) : VIDEO de l'appel des scientifiques européens - 23/03/2009. And see [Exhibit D]

54. I have long been sensitive to wireless communication. With the expansion of Wi-Fi, my problems are increasing.

55. Wireless internet now injures me. Symptoms include headache. The headache goes away when the emissions are turned off or I leave.

56. I have reacted to cell towers 10 miles away. A spectrum analyzer was used to verify radiation levels were present. Wireless broadband already gives no relief to those suffering.

57. Concern: My life and the lives of others are threatened.

58. Concern: Don't we have the right to life?

59. Sometimes the pain from electromagnetic radiaion is instantaneous.

60. Sometimes the injury may not be felt instantly. (I describe it as similar to sun exposure and becoming severely sunburned, feeling it later. When severely sunburned, a little bit of sun or hot water or heat from an appliance is too much)

61. An amazingly very small amount (too little to measure) may injure.

62. Recovery may take minutes to weeks, *if the injured cells do heal*. Cells may remain injured (such as changes in RNA, DNA, chemistry, cell structure, or cancer) or die (dead cells are not cancer). [Exhibit E]

63. New symptoms – chest pain – has appeared.

64. When exposed to electromagnetic radiation, symptoms of mental confusion occur, including incorrect spelling, writing, using wrong words, problems in counting. Sometimes it is painful to think. I can forget how to move muscles to walk, how to write. Sometimes I'm not sure where I am and how to open the shower door to get out.

65. I have not been able to find a hospital for medical care that will not injure me with electromagnetic radiation

66. Concern: Medical facilities present severe problems for me and other sensitive people. An accident occurred; I was taken to emergency. In the X-ray room, I experienced acute pain from electromagnetic radiation and said so. The medical staff told me that the X-ray room was the safest place in the hospital. They did not believe me. I repeated something in the room was wrong! I had a painful headache likely from something in the room. I asked to reduce delays and to get me out quickly. A hospital person entered the room, heard me and remembered that a week earlier Nextel had installed an antenna for wireless communication in the X-ray room. Here was an unplanned double-blind study. It took days to recover from the likely up-close or overexposure.

67. When husband had triple by-pass surgery, I was unable to be there with him as the electromagnetic radiation exposure in the hospital setting would have made me ill.

68. Concern: Electromagnetic radiation can distort medical tests. The symptoms from electromagnetic radiation can actually confuse the proper treatment due to the effects from electromagnetic exposure such as Type 3 Diabetes.

    (Havas, M. (2008). Dirty electricity elevates blood sugar among electrically sensitive diabetics and may explain brittle diabetes. Electromagn Biol Med, 27(2), 135-146)

69. Concern: The functioning of medical personnel may be impaired by their exposure. An unexpected observation/experience led to my awareness of how staff could be unwittingly affected by electromagnetic radiation. My dentist and the assistant both commented how relaxed each felt doing the dental work (my tooth had broken and needed repair). They noted this comfortable/relaxed feeling was unusual. What was different? They had turned off all the compact fluorescent lights, keeping on only the incandescent operation light and the dentist's LED head gear, to accommodate my electromagnetic radiation disability in this minor emergency. These two professionals were unaware they may be electromagnetic radiation sensitive, yet each noticed their health was better without CFL lights. A second visit about a year later, the same response.

70. Concern: Doctors need to be trained to diagnose electromagnetic radiation injury. We are all being exposed to electromagnetic radiation and we are getting incrementally weakened from electromagnetic radiation whether they know it or not.

71. Concern: Medical facilities present severe problems for me and other sensitive people.

72. Where there is electromagnetic radiation, people sensitive/injured try to avoid exposure, they don't go. When I suspected I had a broken toe, I did not go to

emergency. The cell towers, cell phones, fluorescent lights, computers, wireless communication would likely cause greater damage. I did not obtain medical care when I had a red itchy eye (a person with conjunctivitis visited three days earlier). I did not obtain medical care when I had a fever, a cough and a sore throat (it felt like when I had the mumps as a child).

73. I did obtain medical care when I discovered a lump in my breast. Consequences of hospital experience was: mammography showed no cancer, 3 days diarrhea, 5 days tender breasts, 7 days headache. (20060804)

74. Concern: Accommodations are unavailable in hospitals.

75. University of Iowa Hospital and Clinic *"Absolutely no way will we be able to accommodate EMS people"* (20070108)

76. A facilities director at a major university hospital responded to my letter: "*Reading the documentation that was sent makes it clear that anyone with a sensitivity to high frequency electromagnetic radiation should* ***stay far away*** *from The University of Michigan Health System because we emit a lot of it between the various electronic systems that are in use."* While this is a statement that acknowledges the condition, it makes it impossible to enter the hospital for treatment.

77. In West Virginia I am unable to locate a hospital should there be an emergency. The West Virginia Institute of Occupational Medicine responded to my search for medical care: *"I am not able to locate any medical facilities that meet your needs. I am sorry and hope that you have recovered from your cut."* (20090621)

78. To be forced to live in a Faraday cage, a shield from wireless communication that people cannot turn off is inhumane. [Exhibit F] But worse yet, deterioration of health, from un-natural electromagnetic radiation is torture.

79. This past week there was an announcement that the airlines will be installing Wi-Fi in many of their aircraft. Radiofrequency is known to cause heart arrhythmias in some individuals. While this could be extremely discomforting to passengers, reactions to electromagnetic radiation could be potentially serious if a pilot were affected; the results could be tragic.

80. Exposure symptoms include heart arrhythmias, headaches, fatigue, numbness, muscle spasms, rash, itching, vision changes, confusion, difficulty in multi-tasking, slowness in thinking, problems comprehending numbers correctly.

81. Passenger convenience is no excuse for taking unnecessary risk.

82. When further studies confirm the dangers of Wi-Fi, airlines may find themselves liable for installing technology that put passengers lives at risk.

83. To be unable to return home without being harmed and without anywhere to go, and not knowing where or when you can sleep that is safe I call homeless.

84. Escaping electromagnetic radiation means relinquishing comforts most Americans have taken for standard: hot water, heat, access to food, running water, our home, friends/family, occupation, our dreams/future. Survival is primary. Conditions, in my opinion, personal experience and observation of others, are inhumane.

85. People injured by electromagnetic radiation often forego technology and live in primitive conditions.

86. Concern: protected zones from current technology are urgently needed. Newer technologies (the technologies that emit invisible dirty electricity or electro-smog) will create desperate situations for the sensitive and will likely affect the health of everyone.

87. One convenience (that most people in the United States have and what I wanted but did not have) was hot running water to take a shower. Trying to find safe shelter over the past few years, I have had to gathered water from a waterfall from snow melting, when the snow disappeared from a puddle. When I got to a store (40+ miles one-way), I bought water or filled plastic jugs or pails with water. I heated the water to sponge bathe when facilities (such as a wood stove) were available. Sometimes I braved asking people if I could use their shower. A few people were understanding and volunteered use of their shower. Often I washed outdoors (watching and listening for approaching cars). Friends and family who came to visit found this intolerable and refused to use these primitive conditions.

88. Concern: government agencies are not protecting me. Economics and industry seems to have priority over health and life. Don't I have the right to life, the right to live without the invasion of invisible electromagnetic radiation, the right to a future?

89. Concern: exposure standards are inadequate and need to be readdressed using <u>all</u> relevant science, including the most current research which demonstrates, without question, the adverse effects of exposure to low levels of electromagnetic radiation.

90. Electromagnetic radiation injuries/sensitivities/health effects appear to be on the rise and ignored by the FCC.

91. Concern: the number of frequencies we are exposed to is increasing.

92. During the period when I was trying to find a safe shelter, my son felt stressed because his mother was homeless.

93. I am concerned about my husband's safety. Bert spends many hours farming and doing research. The plants do not wait for you to give them attention, weather has an unpredictable window. Because the cell tower emissions injured me, I am not there, I cannot check on him, take him meals, run to get parts, give

him assistance especially when the window of good weather is closing. Now he is on the farm alone, operating farm equipment. I am very concerned.

94. I could not make plans because I did not have security of knowing where I could stay or sleep. If there was electromagnetic radiation and if it made me ill, I needed to find somewhere else.

95. As a business owner, my husband needs to be at our farm. I was a co-owner and partner in our business. Yet, I could not be there, which was frustrating and economically devastating. What I had been doing in terms of management, is still undone.

96. Having been injured by electromagnetic radiation has created a financial strain. We sold half of our income producing farm to buy a house, so hopefully I will be able to live humanely in the radio quiet zone. Yet, my husband still lives in Iowa, because the research farm/business we built is there and it creates a financial strain for him to commute2000 miles round trip. It creates a financial strain because I cannot help in areas that I managed. Overexposure from the U.S. Cellular cell towers electromagnetic radiation emissions disabled me. I am unable to be in environments that have a very small amount of electromagnetic radiation especially the kind from U.S. Cellular (extremely toxic, similar to a peanut allergy). Hence, I cannot pursue my career and my gifts, using the advanced degree I worked for.

97. Concern: Safe areas without electromagnetic radiation are seriously needed, areas near family, friends; safe areas where family, friends can live, so I and electromagnetic radiation injured persons do not have to be excluded. Better yet, the reverse, require wireless electromagnetic radiation be available inside phone booth like structures (keeping the emissions contained). People can enter the booths and use their devices.

98. Many normal activities present difficulties for me. Radiation from cellular, wireless, and cordless devices such as phones injure many electromagnetic radiation sensitive people. People have told me they experience sharp pains and sometimes progressive deafness. An old-fashioned corded telephone may be preferred. Using a speaker telephone at a distance is an option for some electromagnetic radiation sensitive people (including me).

99. Since cell phones, cordless telephones, and Wi-Fi can injure me. Please encourage the availability of corded telephones. I had no access to a telephone when I was homeless. The removal of pay phone and wired internet access leaves me (and others) with extremely limited to *no* communication options..

100. I had to climb over a seemingly tall snowdrift to call to make an appointment. I have had to stand in rain and use the telephone while trying to protect a document I needed for information. On Easter, my telephoning my family was scheduled. Still living in my vehicle, they could not call me. Standing at a cold

payphone was uncomfortable [Exhibit G], but was less painful and damaging than a cell phone.

101. In time consuming calls, the injury increases. I, the caller have to choose between the value of the telephone activity and the injury that is occurring.

102. I already react to Wi-Fi. I get some protection in the radio quiet zone in West Virginia, but it is not perfect, there are hot spots. Wireless broadband nationwide is a disaster happening.

103. We purchased an unfinished house in West Virginia in 2007. The interior was wall studs accessible for modifications for electromagnetic radiation protection. Unfortunately, there is not an expert here to help us design or build this protection effectively which meant we have to become knowledgeable.

104. Adaptations include putting electrical wires in conduits, burying distribution cable, putting electrical appliances at end of house the farthest distance away from living space, switch to turn off refrigerator (so I can access it). Fluorescent lights were removed from the basement because the electromagnetic radiation permeates the ceiling (and the floor of the room above) and injures me. I am still trying to solve heating in winter (either no heat or used a temporary wood stove, motors/fans/blowers injure me therefore no forced air nor heat pumps).

105. To date, I know of no one knowledgeable about heating systems that are safe for electromagnetic radiation sensitive/injured people like me. I am leaning towards radiators for the main floor and PEX floor heating for the second story. I do not know what to do with the always cool/cold basement, as the floor was already cement. As an injured person, forced air, motors, fans, blowers, electrical heaters are immensely painful. The common heat source in West Virginia is wood fed boilers. I doubt I have the strength to feed the fire with large logs. Trying to maintain a wood boiler during cold, snow, and rain would be very difficult for me. How will I manage when my husband is gone? He, himself, just had heart surgery.

106. Comment: One of the many inconveniences that many people injured by electromagnetic radiation is that they have had to leave their homes and their own beds. Since I left home and until May 2009, a month ago, I did not have a "normal" bed to sleep on.

107. We often receive indifference, ridicule or denials of health effects when we contact telephone industries, businesses, manufacturers, local, state and federal governments pleading for protection.

108. Concern: Measuring devices need to be available and results visible and logged so both you and we can measure and log the invisible man-generated electromagnetic radiation that we are exposed to.

109. Concern: It would be useful for people like me if someone would publish electrical field amplitudes, magnetic field amplitudes, and non-ionizing radiation frequencies and amplitudes on technological devices and appliances (in some device/appliance industries, this information is not required and hence is not measured), as well as the electromagnetic radiation environment in areas where one wishes to live.

110. There are many other people whose health responses have repeatedly been associated with certain trigger sources. Some people react seriously to electromagnetic radiation. The only collection of first hand reports of electromagnetic radiation injured people (that I know of). (Granlund-Lind, R., & Lind, J. (2005). Black on White: Voices and Witnesses about Electrohypersensitivity. The Swedish experience (J. Ganellen, Trans.). Sala, Sweden: Mimers Brunn Kunskapsförlaget PDF on-line: www.feb.se/feb/blackonwhite-complete-book.pdf.) [Exhibit H]

111. When electromagnetic radiation emitting devices are installed, those of us sensitive to electromagnetic radiation have to move, leaving our family and friends and abandoning hope for a future, just trying to survive by avoiding injury from electro-magnetic radiation.

112. People with electromagnetic radiation sensitivity should have the right to: freedom from injury; freedom from threat; a right to a future

113. We understand that the EMR Policy Institute is preparing comments to submit in the current Federal Communications Commission proceeding to develop the policy for providing high-speed internet service throughout the country - FCC 09-31, A National Broadband Plan for Our Future.

114. The undersigned and all the persons in our household hereby designate The EMR Policy Institute to speak on our behalf on this FCC proceeding for the purpose of defending our rights to be safe in our own home, in our schools and our workplaces and neighborhoods from the invasion into our home, schools and workplaces of signals that may cause harm to us, because the FCC's current RF exposure guidelines are inadequate in light of the findings of current science.

I ask that the FCC accept this affidavit and the attached exhibits into evidence for consideration under FCC 09-31, A National Broadband Plan for Our Future, as it is material evidence of the existence of signals to which my family and I are subject, yet without proper standards based on current science

Diane D. Schou

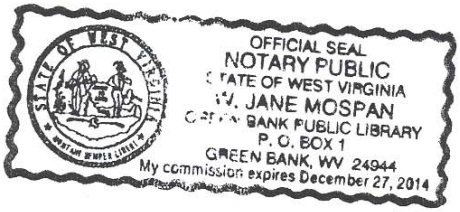
Diane D. Schou, Ph.D.

Sworn to before me

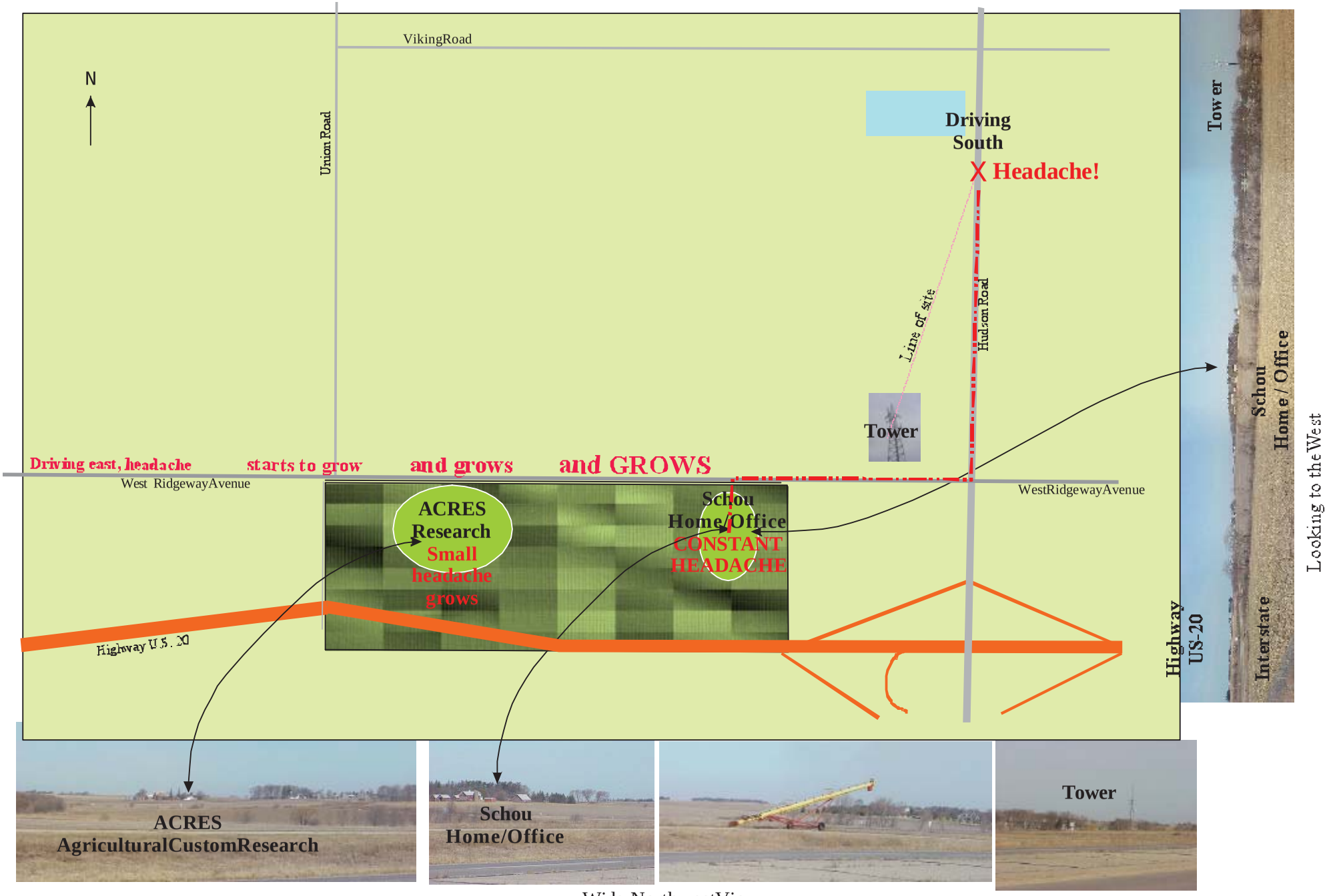
This 5th day of June, 2009

Jane Mospan

Notary Public



[A] Map of cell tower
[B] Letters from doctor
[C] Pocahontas Times
[D] Balmori
[E] Johansson paper
[F] Faraday cage photo
[G] Outdoor telephone
[H] black on white



Wide NorthwestView

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Ellena
Last Name: Kiselev
Mailing Address: 53 West Dr
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Country: United States
State or Province: NJ
Postal Code: 07039
Organization Name: null

KEEP PHONES GREEN & WIRED

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Title: Developing an Unified Intercarrier Compensation
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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Genette
Last Name: Henderson
Mailing Address: 2116 Front St C2
City: Durham
Country: United States
State or Province: NC
Postal Code: 27705
Organization Name: null

Your duty is to facilitate communications for the whole country. The new proposal ignores issues of HEALTH; Safety, Privacy, Affordability and Security. Landlines are safe, secure, reliable, affordable and GREEN.

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Title: Developing an Unified Intercarrier Compensation
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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Suzanne
Last Name: Rodee
Mailing Address: 203 S Whitewater Ave
City: Jefferson
Country: United States
State or Province: Wisconsin
Postal Code: 53549
Organization Name: null

I am asking that landlines remain in place due to the disabilities of many citizens of the United States. Landlines are safer to use for those who are disabled with electrical sensitivity. Many people cannot use broadband or cell phones and will have no means of communicating without the landline phones.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: robin
Last Name: renee
Mailing Address: 3403 farragut ave
City: kensington
Country: United States
State or Province: MD
Postal Code: 20895
Organization Name: null

Hello, I am sensitive to radiation from cell phones and
depend on landlines for all my communicatiion. Get bad
headaches from cell phones.
Pls do not eliminate landlines!
Thanks for your understanding,
~RR

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Stephanie
Last Name: Smith
Mailing Address: 8333 Rockin R Ranch Trl Unit 1
City: Snowflake
Country: United States
State or Province: AZ
Postal Code: 85937
Organization Name: null

Please do not abandon landlines. For health reasons, many people cannot tolerate cell phones and rely upon the relative safety of landlines to communicate with the world.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Kellie
Last Name: West
Mailing Address: PO Box 170
City: Santa Monica
Country: United States
State or Province: CA
Postal Code: 90404
Organization Name: null

Hello,

My comments are in support to KEEP telephone landlines and cable internet connection:

1. Landlines are safe and reliable. I do not have to worry about the call "dropping" or continual amounts of radiation (to whatever degree) that I do with a cell phone or wi-fi.

2. Very important: the Solar Cycles are heating up again (cycle 24). There have been large flares already and CME. If satellites are damaged during an intense flare and knocks out cell communications - then where would we be without are trusted landlines (if they are phased out).

3. Wi-fi is iffy. I work from home and need safe and reliable connection. I use, and ma very happy with, my ethernet cable connection. When I use wi-fi, it's slow and connections often drop. Also, they are not very data safe in transmission.

4. Big Issue: there is now continual and exponential growth of cell towers, antennas, and now wimax. Our environment is polluted with all the EMF smog. It's damaged our own bodies, wildlife and plant life. This is totally irresponsible for keeping safe guard over our dear environment.

Landlines are wonderful, safe, reliable and pretty much affordable. Is it really the FFC's role to decide if these should be phased out?

There are just too many issues, and growing issues, with cell towers / antennas, and wimax. There needs to be much wisdom before forging ahead and making long-lasting decisions without considering all the ramifications.

Landlines are vitally important to our society.

Thank you,
Kellie

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Submitter Info:
First Name: Virginia
Last Name: Farver
Mailing Address: 1214 Belleview Drive
City: Fort Collins
Country: United States
State or Province: CO
Postal Code: 80526
Organization Name: null

I lost my Son, Rich at the age of 29, 1 week after his last birthday from glioblastoma multiforme brain cancer. Rich, had T-Mobile cell phone and was also involved with a cell tower on the SDSU campus in a," Brain Cancer Cluster." My Son, died on the FCC's dime! Litterally! The FCC knows these emissions are killing people every day! I no longer own a cell phone or cordless phone, and never will again! Dr. Keith Black (Cedar Sinai), knows cell phones cause brain cancer but excepted 15 million for a wing to the hospital. Ronald Herbermann from Pittsburgh University was," Let Go," because his is a man with morals! The University let him go because of the loss of 15 million in dontations from the Telecom Industry. Qualcomm to date is the largest donator to SDSU in it's History. 2005-2006, Qualcomm dontated or," Gifted," 57 million to San Diego State University! This tower is GWEN, HPWREN, and I know HAARP! Not only is our Government Agencies and Departments cloaked in Sheeps clothing, but show themselves innocent! We have the MOST EVIL and corrupt Government there is! The FCC is One of the most EVIL! There will be so much emissions from all of these towers, cell phones, smart meters and wifi, WELCOME to my world! Not only will you have my emotional heart break at sometime in your lives, but you or one of your loved ones will be effected by these emissions! Good Luck! IF you get rid of my landline, the masses will figure this out sooner than later! I live with such sadness every day and this has all but destroyed my life and the lives of my only Surviving Son! I hold you responsible for the next," Tobacco - Lung Cancer," scandal! Congrats, wish you and your families the same! Its all about MONEY!

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Submitter Info:
First Name: Betty
Last Name: Phillips
Mailing Address: 466 Eagle Point Rd
City: Pittsboro
Country: United States
State or Province: NC
Postal Code: 27312-6192
Organization Name: null

I was HORRIFIED to find out that our government might be taking away our right to landline telephones! They are SAFE, AFFORDABLE and RELIABLE. We just divested ourselves of all of our wireless technology because of EMF POLLUTION! We NEED our landline to have reliable internet and TV services because we live in a rural area.

OUR GOVERNMENT should help citizens and provide workable alternatives, not be a heavy handed big brother fostering the interests of business over citizens.

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Submitter Info:
First Name: Amanda
Last Name: Lotas
Mailing Address: 256 Sea Oats Trail
City: Kitty Hawk
Country: United States
State or Province: NC
Postal Code: 27949
Organization Name: null

Do not replace existing landlines with wireless infrastructure! I do not want my right to a landline taken away. Some of us cannot use wireless devices without headaches. Nor do many of us believe they are safe.
?
Landlines are safe.
Children, people with medical implants, people with Radiofrequency Sickness, and people who don't want to increase their risk of cancer can use only landlines.
?
Research on radiofrequency radiation exposure indicates increased cancer incidence, altered blood glucose levels, weakened blood-brain barrier.
?
Many in the public cannot use any cordless or wireless phone without developing headaches that are often severe.
?
Landlines are secure. Cabled phones ensure privacy.
Using mobile phones makes us vulnerable to hackers who commit financial fraud. It makes us vulnerable to terrorists.
?
Landlines are reliable.
During power outages and natural disasters, landlines are dependable.

Teleconferencing can be unreliable with broadband connections.? Failure to initiate a conference call is a common problem with VoIP (Voice over Internet Protocol) carriers. Teleconference systems often cannot decode the DTMF tones sent by VoIP service providers so that the systems are unable to recognize some of the keys entered for the passcode resulting in failure to initiate the teleconference.? VoIP calls are also often dropped midstream.
?
Wireless telecom equipment can cause disasters. ABC News confirmed on April 26, 2009 that the Malibu, California fires were caused by utility poles overburdened by cellular phone gear.
?
Landlines are affordable.
We already have the infrastructure for landlines.
?
Mobile phones fees are unregulated.
?
Mobile phones and computers need constant repair, upgrades and replacement.? Seniors and low-income citizens can't afford this. Equipment for landlines is durable and economical.

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Submitter Info:
First Name: Janet
Last Name: Johnson
Mailing Address: imajan2@comcast.net
City: Plainfield
Country: United States
State or Province: NH
Postal Code: 03781
Organization Name: null

To Whom It May Concern,
Please, please, please do not eliminate telephone land lines. For people like me who are affected by electromagnetic fields, this is devastating. Exposure to electromagnetic fields has already made many of us unemployable, unable to function normally, and an unnecessary expense to our society.
In my case, exposure to Electormagnetic fields caused brain fog. I was unable to think clearly, solve problems, or comprehend what preople were saying to me.
I was a special needs teacher with two Master's Degrees from Boston College. I have been unable to work for 15 years and am on disability. The source of my problem I have learned is from mercury amalgam in my teeth. It appears that electrical fields can increase the release of mercury from amalgam in the mouth and cause poisoning. I have been treating for 4 years to remove mercury from my body and am now able to use a computer and think clearly for short periods.
Worse yet, most people like me are unable to defend or represent themselves because they are unable to use computers or be in public buildings with computers and fluorescent lights. It is a "Silence of the Lambs" situation.
There is also concern about children, cell phones, and cancer. The citizens in this country have enough health problems from environmental toxins. Please don't make it worse. This is not good for our country, for humankind, or for our culture.
Please think about your fellow humans.
Janet Johnson

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Submitter Info:
First Name: Ann
Last Name: Engelstad
Mailing Address: 2710 11th Street
City: Winthrop Harbor
Country: United States
State or Province: IL
Postal Code: 60096
Organization Name: null

THE SWITCHED TELEPHONE NETWORK MUST BE MAINTAINED

I am disabled by digital cell phones and other electro-magnetic fields.

I depend on LAND LINE ACCESS.

When digital cellular towers came to the Chicago area (1996-97), within 1 week I had to use a cane - I still am.

By January 197 I had to stop driving due to neurological symptoms from digital electro smog.

Without land line access, I won't be able to make or receive phone calls.

Replacing the switched telephone network will interfere with the rights of 10 million Americans like me.

Depriving 10 million people from using a telephone because it disables them is a violation of the "Americans with Disabilities Act" (A.D.A.).

THE SWITCHED TELEPHONE NETWORK MUST BE MAINTAINED!

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Leah
Last Name: Spitzer
Mailing Address: 1605 Island Way
City: Buford
Country: United States
State or Province: georgia
Postal Code: 30519
Organization Name: null

I am strongly opposed to the elimination of landlines and the promotion of cell phone only communications. As someone who suffers from Chemical and EMF sensitivity, this would be devastating for my health! In addition, there are studies now proving that cell phones affect the brain...we just don't yet know the long term affects.

Free trade means allowing consumers to have choices. Having corporations dictate what choices we have is NOT a democracy.

Please dismantle this proposal! It limits consumer choices and risks the health of every American.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Stefanie
Last Name: Beninato
Mailing Address: PO Box 1601
City: Santa Fe
Country: United States
State or Province: NM
Postal Code: 87504
Organization Name: null

The proposed rule will increase radiation dramatically without knowing its effects. I am opposed to the creation of a blanket of radiation over the entire nation especially in light of recent studies showing brain chemistry changes with the use of cell phones alone. I also oppose it because it makes our country?s communication system more vulnerable and our environment more dangerous for other species as well as aesthetically unpleasing.
We need current and objective studies of the health effects especially the cancer clusters showing up around cell towers.
I have noticed that I am be coming increasing aware of being around intense wifi use. I do not want to continue to expose my safety to non-standards (categorical exclusions) or standards based on nearly thirty year old studies.
Cell phone industry told us there was no effect on the body when using a cell phone. We now know that is not true. What other misunderstandings and misrepresentations does this technology operate under? It is time to put public welfare and safety first.
In addition a phone network based on wireless technology will make it impossible for at least 3 percent of the population to live under those circumstances and would be a clear violation of the ADA, with which the Telecommunication Act has to comply.
Fiber optics is a viable alternative technology that the government should be encouraging and funding not only for health but also for environmental and health effects. I know there is a study being undertaken or sought on cell phone towers effects on collapse of bee colonies...
Hong Kong has successfully established a high end internet/phone access that is many times what one can get in the US. Just think how fiber optics would preserve skylines and vistas throughout the country.
Please do not curtail individual choice. Please do not make cell phone technology the only option until the health issues are adequately addressed with current, objective studies.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Michelle
Last Name: Moore
Mailing Address: 237 B Irvine Street
City: Santa Fe
Country: United States
State or Province: NM
Postal Code: 87501
Organization Name: null

I oppose ending the availability of landlines !! There are not enough studies to conclude that the frequencies in wireless communications, especially those used by cell phones, are completely harmless to human health. One size does not fit all. I know there are individuals who are sensitive to their transmission. To end landlines is the equivalent of removing smoking bans where these individuals have no comfortable way to communicate and stay connected to family and friends.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Suzanne
Last Name: Olson
Mailing Address: 2710 Melendy Drive #7
City: San Carlos
Country: United States
State or Province: CA
Postal Code: 94070
Organization Name: null

I use a land line because cell phones are unhealthy. I use my cell phone very rarely. Please protect our health and support the use of land lines.

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Title: Developing an Unified Intercarrier Compensation
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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Mary
Last Name: Adkins
Mailing Address: 143 Peaked Rock Road
City: Wakefield
Country: United States
State or Province: RI
Postal Code: 02879
Organization Name: null

I am writing to oppose any program that will eliminate landline telephones. As a person who suffers severe adverse health effects from cell phones and other radiation-emitting devices, I depend on landline phone service in order to communicate with family and friends and conduct day-to-day business. My two children also have severe health problems from cell phone radiation. Eliminating landlines will give us no options with regard to communication and amounts to discrimination. EMF sensitivity is recognized by the U.S. Access Board and Americans with Disabilities Act. There are literally thousands of published, peer-reviewed scientific studies documenting the dangers of cell phone radiation and to force this upon the general public and remove landline service is unacceptable. Please maintain the switched telephone (landline) network so that the 10 million people who are affected by EMF sensitivity still have access to communication.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Beth
Last Name: Sehlmeyer
Mailing Address: PO Box 1195
City: Dover
Country: United States
State or Province: NH
Postal Code: 03821
Organization Name: null

As a person with sensitivity to EMF's I am writing to request that you maintain the switched telephone network.
I, along with 10 million other Americans depend on the
switched telephone network for voice communication. "Universal Service"is not universal if it excludes 10 million people. Eliminating landlines will leave me, as well as millions of Americans without even basic telephone service.

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Public Comments on Developing an Unified Intercarrier Compensation:========

Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Patricia
Last Name: Oates
Mailing Address: PO Box 481
City: Fairfield
Country: United States
State or Province: IA
Postal Code: 52556
Organization Name: null

To whom it may concern:

There are still many of us who oppose the creation of a "wired" world. We feel that there are potential dangers to health and well-being that have not yet been documented.

We oppose this measure which would end land lines for so many (including us) and force us to live in a perpetually lively electromagnetic field, the health results of which have not yet been tested. (Some of us have already had alternative practitioners who are able to determine that our bodies and minds do not function well in a wired atmosphere.

We oppose any measure which would rid us of landlines.

Thank you.

Patricia and Robert Oates

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Donna
Last Name: LaBrie
Mailing Address: 569 N. Rossmore #105
City: Los Angeles
Country: United States
State or Province: CA
Postal Code: 90004
Organization Name: null

I'm sure you will gather a multitude of comments from well-informed people about the health hazards of cell phones and cell phone towers. For some odd reason, here in America, the Swedish studies tend to be ignored and the best we come up with is that research determining cell phone harm is "inconclusive". C'mon folks. That conclusion flies in the face of common sense. It seems that "science" can be manipulated when confronted with the power of a billion dollar cash cow with friends in high places. Are brain tumors to be the new, modern day collateral damage in a war for consumer dollars?

I work as a counselor from my home. I work exclusively on the telephone. I don't (and won't) have a cell phone because I value my brain and my health. I notice, as more and more clients call me on their cells, clarity of transmission has become more and more degraded. Calls are often fuzzy, inaudible and dropped calls are common with people having to call back repeatedly. Banning landlines is a terrible idea if communication is the goal. More importantly, banning landlines is a terrible idea if public health and an exponential strain on the current health care system is of any concern to those in a position to make a reasonable decision.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Bradley
Last Name: Leach
Mailing Address: 1507 Sir Francis Drake
City: San Anselmo
Country: United States
State or Province: CA
Postal Code: 94960
Organization Name: null

Please do not eliminate land lines. Many people still use them and they are safe from the microwaves that cell phones and cordless phones produce. Let us have the choice of using land lines. What is the purpose of eliminating them, other than pandering to the big telecom companies? Also, land lines are more reliable in many places of the country.

Bradley Leach

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Mari
Last Name: Friedman
Mailing Address: P.O. Box 3473
City: Boulder
Country: United States
State or Province: CO
Postal Code: 80307-3473
Organization Name: null

Landline service is absolutely essential to many people and must be preserved.

There is a portion of the populace who cannot use wireless technologies due to health constraints, especially those with electromagnetic sensitivities. I am one of those people. This prevents us from using the cellular phone system. We rely exclusively on the landline switched telephone network for voice communication.

Removing landline service would deny us access to phone service, a fundamental and essential right and resource. This would also constitute a serious violation of the Americans with Disabilities Act (ADA). In light of these facts, it is clear that elimination of landline service should be prohibited.

For a brief review of pertinent information regarding those with environmental sensitivities, please visit the U.S. Architectural and Transportation Barriers Compliance Board (Access Board) at http://www.access-board.gov/research/ieq/intro.cfm

Furthermore, children, people with medical implants, people with Radiofrequency Sickness, and people who don't want to increase their risk of cancer can use only landlines. Research on radiofrequency radiation exposure indicates increased cancer incidence, altered blood glucose levels, weakened blood-brain barrier. Many of us in the public cannot use any cordless or wireless phone without developing headaches that are often severe. Imagine people with Alzheimers or other dementia trying to learn how to initiate cell or computer calls.

We already have the infrastructure for landlines. Mobile phones fees are unregulated. Mobile phones and computers need constant repair, upgrades and replacement. Seniors (like myself) and low-income citizens can't afford this. Equipment for landlines is durable and economical and reliable.

As a nation, we must reduce our use of power and greenhouse gas emissions. Corded landlines require minimal electricity compared with antennas that emit radiation continuously. Cellphones require recharging.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Virginia
Last Name: Farver
Mailing Address: 1214 Belleview Drive
City: Fort Collins
Country: United States
State or Province: CO
Postal Code: 80526
Organization Name: null

I'm writing in regards to eliminating landlines. This is my only source of communications. I lost my Beautiful 6'2" Son from glioblastoma multiforme brain cancer. His Neurosurgeon told our family it was from cell phone use. Rich, (my Son), was also involved in a brain cancer cluster on the SDSU campus in San Diego. 4 people within the last 2 years have died from brain cancer who share a building and room on campus. Corruption at every turn. The main stream media will not do a story because it would be bad for the city of San Diego and SDSU. This tower outside of this little area on campus is GWEN and HAARP. This will be my never ending goal, to get this story out! The FCC IS responsible for the emissions of cell phones and cell towers. By some chance this Department doesn't think so, then I would ask why the FCC is even needed? It comes down to Money, sadly, Money! I envite you to come into my home to see what losing a child is like! From the Sunrises in the mornings, birds singing, to the sunsets in the evenings, there no longer is any joy, nor will there ever be. This is a loss that cannot be fixed! If the Proliferations of these towers continue, your own families will be at risk! Anything wireless is dangerous and this agency knows it! If you allow this, you will be putting your own families at risk, and is Money worth this? Absolutely, NOT! Until the CTIA and others are held accountable, I fear for Humanity! Money is the root of all evil, and I truely believe this! God will and does care of evil. How many kids will die before the body count will be high enough for our Government? I saw a bumper sticker, (I love my country, but hate my government). How fitting!

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Linda
Last Name: Ronchetti
Mailing Address: 15 N. Erie Street
City: Aurora
Country: United States
State or Province: MN
Postal Code: 55705
Organization Name: null

No, no, no to eliminating land lines. I absolutely am not convinced that cells phones are not causing me problems. I can hear better on a land line, which also doesn't bother my ears like a cell phone, with or without head phones. The land line is not nor should it become obsolete. And what about areas where reception is poor? Once again, the land line works in my area.
Please reconsider and leave it for us who use it as our phone of choice.
thank you.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Dawn
Last Name: Grenier
Mailing Address: 8675 Hansa Trail
City: Snowflake
Country: United States
State or Province: AZ
Postal Code: 85937
Organization Name: null

I writing to let you know that maintaining the landline telephone system is very important for a segment of the population disabled by electrical hypersensitivity. The United States Access Board estimates that 3% of the population of the US have some electrical sensitivity meaning that they can not use or have difficulty using cellular phones and computers. Elimination of the landline telephone system will leave us unable to communicate and cut off from the world. There is also the issue of cost since cellular service is often much more expensive. Many elderly people don't want to or are unable to learn to use cell phones and computers. Please consider the needs of all members of society in your rulemaking.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Teresa
Last Name: Swinbourne
Mailing Address: PO Box 7415
City: Portland
Country: United States
State or Province: Maine
Postal Code: 04112
Organization Name: null

It is absolutely inappropriate to eliminate land line usage in the United States. There is a population, over 10 million, who are unable to use wireless devices. Furthermore, there are Americans who do not have internet access. How could this be possible to eliminate a vital communication device? Assuming that citizens could replace their landlines with cell phone or applications like Skype is short sighted and irresponsible. Hardwired technology has a proven track record with very little controversy. It is without question that the FCC is being influenced by the wireless industry and that is a tragedy for Americans and our health. Please consider the long-term effects of such a short sighted proposal. Do we have to continue to trade cost savings that are perceived for our health and safety?

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Jennifer
Last Name: smith
Mailing Address: PO Box 1277
City: Flagstaff
Country: United States
State or Province: AZ
Postal Code: 86001
Organization Name: null

Hello, Eliminating landlines will leave millions of Americans without even basic telephone service. I electromagnetic sensitive. For health reasons I keep land lines as my primary phone. Please do not switch all phones to cell phone as it is not healthy for the population.

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Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Julie
Last Name: Andrus
Mailing Address: 112 Seymour Ave SE
City: Minneapolis
Country: United States
State or Province: MN
Postal Code: 55414
Organization Name: null

It is critical that the switched telephone network be maintained in the United States. Many people do not find cell phone use a good choice for themselves for a variety of reasons. It is not possible by some to use cell phones due to disabilities. Don't leave millions of people out. Keep land lines. I personally am comfortable talking on land lines and dislike using cell phones so save them for special use. Keep our switched telephone service! Thank you. Julie Andrus

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Ron
Last Name: Peterson
Mailing Address: PO Box 142
City: Gasquet
Country: United States
State or Province: CA
Postal Code: 95543
Organization Name: Ron Peterson Family & Friends

My family supports of requiring continued maintenance of landline telephones. Many of us, including many of my family and friends, rely on landlines, According to?the Access Board,?an estimated 3% of the population, or almost 10 million Americans, have electromagnetic sensitivities (http://www.access-board.gov/research/ieq/intro.cfm).?Many, including my family and friends, cannot use wireless technology and have difficulty using computers. We depend on the switched telephone network for voice communication. "Universal Service" is not universal if it excludes 10 million people. Eliminating landlines will leave millions of Americans without even basic telephone service. Do not bend to the will of the powerful- do right by the people of the United States!

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Sara
Last Name: Perron
Mailing Address: 38148 Beecher Drive
City: Sterling Heights
Country: United States
State or Province: MI
Postal Code: 48312
Organization Name: null

Please do not replace existing landlines with wireless infrastructure until it is proven safe, secure, reliable and affordable!

When I rarely use a cell phone for five minutes or less I get pain in my ear that last for approximatly 30 minues. I use a landline in my home to avoid RF radiation.

Children, people with medical implants, people with Radiofrequency Sickness, and people who don't want to increase their risk of cancer can use only landlines.

Research on radiofrequency radiation exposure indicates increased cancer incidence, altered blood glucose levels, weakened blood-brain barrier.

Many in the public cannot use any cordless or wireless phone without developing headaches that are often severe.

Please do not make cell phones the only source of communication for all. They are not safe!

Sincerely,

Sara K. perron

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Rosalie
Last Name: Bertell
Mailing Address: 1750 Quarry Rd
City: Yardley
Country: United States
State or Province: PA
Postal Code: 19067
Organization Name: International Physicians for Humanitarian Medicine

The FCC has no competence to make decisions that effect the health of citizens. There are serious life-death judgements involved in depriving citizens of land lines, making them obsolete, expensive or worse, unavailable. In addition to the serious risk of EM radiation, this proposal is unfair to the poor, children, the elderly and those with dementia.

Dr. Rosalie Bertell

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Patricia
Last Name: Barth
Mailing Address: 12 Reservoir Rd.
City: Shokan
Country: United States
State or Province: NY
Postal Code: 12481
Organization Name: null

I'm opposed to being FORCED to go "wireless only" for telecommunications. This will affect millions of Americans to have to buy new equipment and it will be a big expense to those who can least afford to do so. Landlines are also always on in case of emergency. For those who wear a panic button, that equipment will no longer operate.

We are already bombarded with microwaves from cell towers and other dangerous emissions. I would rather that wireless go the way of the dinosaur than to eliminate fiberoptic landlines.

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Susan
Last Name: MacKay
Mailing Address: 9059 Charolais Trail
City: Snowflake
Country: United States
State or Province: AZ
Postal Code: 85937
Organization Name: null

I would like to ask that you maintain the switched telephone network. This is essential to my ability to maintain contact with the world since I am one of the estimated 10,000 million americans (3% of the population)with electromagnetic sensitivities. I depend on landline voice communication to meet my needs, especially since I am disabled by severe chemical sensitivities and basically housebound. I am unable to use wireless technology such as cell phones and have difficulties using a computer. Replacing the current landline telephone system with a totally broadband system would leave me with no way to communicate. Landline telephone access is essential to me. A system that would leave me and the many others who have electromagnetic sensitivities without the ability to communicate would not be a universal communications system at all. Thank you for your consideration.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Diane
Last Name: Haavind
Mailing Address: 200 Columbia Hts.
City: Brooklyn
Country: United States
State or Province: NY
Postal Code: 11201
Organization Name: null

It is essential to maintain the switched telephone network.
This network is crucial in terms of emergency shutdowns of other communications, and it is also crucial to the millions of people who have electromagnetic sensitivies as I do and to those with other disabilities that prevent their use of other forms of communication.

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: calliope
Last Name: rigos
Mailing Address: 30 pilot street
City: bronx
Country: United States
State or Province: NY
Postal Code: 10464
Organization Name: null

Switched telephone network must be maintained. , I know many persons who have lectromagnetic sensitivities. There are also many elderly people in my family who cannot use wireless technology and have difficulty using computers. They depend on the switched telephone network for voice communication. "Universal Service" is not universal if it excludes 10 million people. Eliminating landlines will leave millions of Americans without even basic telephone service.

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Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Ted
Last Name: Luce
Mailing Address: 3605 S. Liberty
City: Independence
Country: United States
State or Province: MO
Postal Code: 64055
Organization Name: null

In spite of the many advancements made in internet technology, I fully believe that telephone landlines should still play a role in communication in this country.
They are used by businesses and are crucial due to their use with most conventional home and business alarm systems.
Furthermore. telephone landlines offer a secure form of communication that cellular and VOIP systems do not.
Also, it is reported that 3% of the American population suffers from electromagnetic sensitivity. These citizens are adversely affected by cellular and wireless systems. Most cannot even use computers in their homes. They depend on switched telephone networks as their communication link.
"Universal service" is not universal if it excludes 10 million users.
Eliminating landlines will leave millions of Americans without basic phone service.
Thank you for your attention in this matter.

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RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Kate
Last Name: Henson
Mailing Address: 2441 Shallowford Rd
City: Atlanta
Country: United States
State or Province: GA
Postal Code: 30319
Organization Name: null

Don't get rid of land lines. It is a national security issue, and there are significant health risks involved with wireless voice and data transmissions. Give this more time to sort out the risks.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Maria
Last Name: Pena
Mailing Address: Fay
City: Elmhurst
Country: United States
State or Province: IL
Postal Code: 60126
Organization Name: null

I am opposed to the proposition for replacing land lines with all cellphones. I have multiple family members with health problems including pace makers and we believe that the waves may interere with normal function. There is also a concern for young children, whom I do not allow cell phones near their growing nervous systems.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Patricia
Last Name: Ormsby
Mailing Address: 3074 S. Eudora
City: Denver
Country: United States
State or Province: CO
Postal Code: 80222
Organization Name: null

I understand that the proposed rule would defund conventional landline telephone service, eliminating it in favor of wireless service or computer-based communication. This would be a nightmare for people with the disability known as electrosensitivity, who rely on landlines for communication because wireless devices make them ill and they similarly find computer use difficult. They are already isolated in the modern world of wireless IT and would become more so under the proposed rules.
I, for example, become ill when having to spend time in a house with cordless telephones, wireless modems and/or CFL lightbulbs. When I am travelling, I tell people not to expect a call from me, because it is too hard to find a public telephone in many places. There are reportedly about ten million people (3% of the population) who share my difficulty in America. We are already unable to tolerate the wireless environment in many public spaces, such as aboard trains or buses, in libraries and schools, etc. We are socially isolated. The loss of landlines would force further suffering on a significant portion of the American public. I hope you will reconsider this proposed rule and not further handicap this disadvantaged group.

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Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Virginia
Last Name: Cooper
Mailing Address: 6786 Cowles Mtn. Blvd.
City: San Diego
Country: United States
State or Province: CA
Postal Code: 92119
Organization Name: null

I cannot use wireless technology, cable or computers due to being eletromagnetically sensitive to the point of not being able to breathe. I depend on the Switched Telephone Network for voice communication. Universal Service is not universal if it does not include 10 million disabled people like me.

Virginia Cooper
San Diego, CA
(Comment Entered by Daniel Fischer)

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FR Document Number: 2011-04399
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RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Brett
Last Name: Crump
Mailing Address: 2271 S Moeller Cir.
City: New Palestine
Country: United States
State or Province: IN
Postal Code: 46163
Organization Name: null

My wife has electromagnetic frequency sensitivity. She cannot use cell phones. Please do not eliminate land line phones for those who are sensitive to EMF. Thank you for your consideration.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Alison
Last Name: Kelley
Mailing Address: 25 Canterbury Court
City: Newtown
Country: United States
State or Province: PA
Postal Code: 18940
Organization Name: private citizen

WE do not want elimination of all land lines. this would put the country in jeopardy. In addition, it is way too much EMFs to be cluttering our lives. Don't do it.

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FR Document Number: 2011-04399
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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Jaime
Last Name: Schunkewitz
Mailing Address: 10 Abedim Way
City: Califon
Country: United States
State or Province: NJ
Postal Code: 07830
Organization Name: ahappyhabitat.com

I suffer from Electromagnetic Hypersensitivity and am
legally disabled as a result of it. Cell phones cause
severe reactions. Please don't dismantle the land-line
phone system - unless of course you have a scheme
to eliminate people such as myself.

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: jennet
Last Name: grover
Mailing Address: 42 sunlit drive west
City: santa fe
Country: United States
State or Province: NM
Postal Code: 87508
Organization Name: null

dear people -
we do NOT want cell towers or the use of WiFi anywhere near our city or suburbs.
thank you - jennet

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Legacy Document ID:
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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: William
Last Name: Sarill
Mailing Address: 87 Williams St.
City: Arlington
Country: United States
State or Province: MA
Postal Code: 02476
Organization Name: null

I am deeply concerned about the FCC's proposed elimination of landlines to the extent that it will instead foster an enforced expansion of cell phone usage. I recognize that adverse health effects of cell phone radiation is a controversial issue. However, as an independent scientific researcher I have verified to my own satisfaction using infrared thermography that cell phone usage can strongly affect biological tissue. The long term effects of cell phone radiation may not be apparent for a few decades; meanwhile we are subjecting an increasingly large percentage of the population (particularly younger people) to microwave radiation. I do not think it is fair to use an increasing number of American citizens in a vast experiment, the end results of which will not become evident for years to come. A more conservative approach to the potential hazards of electromagnetic pollution is called for. One step in this direction is to limit cell phone usage by not eliminating landlines. Even if FCC decides that there is no health risk to the use of cell phones, I believe that the decision to use them or not must be left to the individual consumer. If landlines are eliminated, freedom of choice for the consumer has been curtailed.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Rae
Last Name: Pellegatti
Mailing Address: 3007 W Jordan
City: Phoenix
Country: United States
State or Province: AZ
Postal Code: 85086
Organization Name: null

Because of electrical sensitivities and current disabilities, I rely on using a telephone via land line. Only having cell phones would greatly impair my daily living.

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Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Kathy
Last Name: Carrell
Mailing Address: 3016 County Road 743
City: Princeton
Country: United States
State or Province: TX
Postal Code: 75407
Organization Name: null

Please maintain the switched telephone network. According to the Access Board, the federal agency that administers the Americans with disablities Act, an estimated 10 million Americans have electromagnetic sensitivites. They cannot use wireless technology and they have difficulty using computers. They depend on the switched telephone network for voice communication. Eliminating landlines will leave millions of Americans without basic telephone service. PLEASE MAINTAIN THE SWITCHED TELEPHONE NETWORK. Thank you for your consideration.

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: jane
Last Name: odin
Mailing Address: 511 piedmont
City: taos
Country: United States
State or Province: NM
Postal Code: 87571
Organization Name: the human race

I?m shocked at the FCC proposal to eliminate landline phones. Millions would be forced to give up phone service because of microwave frequency sensitivities. I am one of them and find myself mentally prepared to live without your proposed wireless services. I?m just not interested in having a MW antenna in my home.

The US government recently warned the masses to forego cell phone use in favor of texting because cell phones are thought to be dangerous to the health. As you must know ? cell phones gravely impact the immune system, thereby allowing a myriad of chronic and terminal illness to develop. I believe the warning, apparently the FCC does not.

The MW frequency effect is cumulative meaning those unaffected today will likely be experiencing debilitating nausea and stomach dis ? ease in the future. Brain tumors and other cancers will take longer to manifest. Eliminating land lines will eventually have an unimaginable impact on the health of children, the elderly and the sick.

It will be interesting to see how folks enjoy living in a world of the totally dumbed- down. The MW frequency creates a low-Alpha wave brain frequency comparable to a 10 year olds mentality. Indications of this transformation are already quite evident in the world around us.

Eventually the market place and social networking will be will be affected by the elimination of phone books ? or have you fantasized a method of listing billions of ever changing cell phone numbers.

Most folks are unaware of this proposal. It is totally unpublicized. Come on guys, show a little humanity and courage. Give the prospective 10 year olds an opportunity to respond.

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Public Comments on Developing an Unified Intercarrier Compensation:========

Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Nancy
Last Name: Fallaw
Mailing Address: 17 Channing Street
City: Quincy
Country: United States
State or Province: MA
Postal Code: 02170
Organization Name: null

The switched telephone network must be maintained. The Architectural and Transportation Barriers Compliance Board ("the Access Board"), is the federal agency that administers the Americans with Disabilities Act. According to the Access Board, an estimated 3% of the population, or almost 10 million Americans, have electromagnetic sensitivities. My name is Nancy Fallaw and I am electromagnetic sensitive and cannot use wireless phones and have difficulty using a computer. I depend on the switched telephone network for voice communication. "Universal Service" is not universal if it excludes 10 million people. Eliminating landlines will leave millions of Americans without even basic telephone service.

My business requires that I use a phone (which is wired) If the US switches over to wireless I will be unable to work..my livelihood depends on my ability to use a wired phone. I depend on the switched telephone network for voice communication. "Universal Service" is not universal if it excludes 10 million people. Eliminating landlines will leave millions of Americans without even basic telephone service including me.

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Public Comments on Developing an Unified Intercarrier Compensation:========

Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: JOHN
Last Name: WALKER
Mailing Address: 32 GREYSTONE ROAD
City: SAUGUS
Country: United States
State or Province: MA
Postal Code: 01906
Organization Name: null

MY NAME IS JOHN AND I AM VERY SENSISTIVE TO EMF'S INCLUDING THOSE FOUND IN CELL PHONES. I ONLY USE A CELL PHONE IF IT IS AN EMERGENCY. SWITCHING THE OLD POTS SYSTEM WOULD BE DETERMENTAL TO MY HEALTH AS WELLS AS MY COLLEAGUES.

PLEASE CONSIDER THE HEALTH OF THOUSANDS OF PEOPLE WHO SUFFER FROM THIS DISEASE INCLUDING CHILDREN.

I CAN BE REACHED AT 781-361-3222 AND 781-233-3793 IF YOU NEED ANY CLARIFICATION

SINCERELY,

JOHN

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Diane
Last Name: M
Mailing Address: P.O. Box 633
City: Hancock
Country: United States
State or Province: MI
Postal Code: 49930
Organization Name: null

Please do not phase out landlines, as this would interfere with access for may people. Cell phones are not advisable for everyone--there is evidence that many people suffer from EMF sensitivities (perhaps we all do). In addition, landlines are more reliable in certain kinds of emergencies. We need to be MORE inclusive with our services, not less.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Elizabeth
Last Name: Masters
Mailing Address: 2690 Bloor St. West
City: Toronto
Country: Canada
State or Province: Ontario
Postal Code: M8X 1A5
Organization Name: null

Please do not dismantle the telephone landlines
This will be a disaster for electrosensitive people who cannot use a cell phone. Before many of them became electrosensitive, these people had often developed illnesses like chronic fatigue syndrome and multiple chemical sensitivities. As someone with CFS and MCS, I do not want to use wireless technologies because I feel potentially vulnerable to developing electrosensitivity. Please do not take the choice to use landlines away from people like me.

Eliminating landlines will leave millions of disabled Americans, many of whom are shut-ins living difficult lives, without even basic telephone service.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Norman
Last Name: Andreassen
Mailing Address: PO Box 51
City: Dolan Springs
Country: United States
State or Province: AZ
Postal Code: 86441
Organization Name: null

Millions of Americans don't tolerate cell phone signals. This proposal would leave them without access to police and emergency services, information, contact with family and friends, etc. Many Americans can't even receive a call from a cell phone without experiencing severe pain (even if they themselves are on a land line). Cell phones are not legal for children in some nations and the technology has yet to be proven truly safe. The technology is much too new to be certain that it's safe?problems could develop over many years. The intent here seems to be to push this through before the the facts are in and before the public has been consulted. The cost of replacing the land lines will be prohibitive, so once they're gone, they're gone. What's wrong with some redundancy? What's wrong with consumer options? What's wrong with not putting all your eggs in one basket?

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Carol
Last Name: Moore
Mailing Address: PO Box 344
City: Unionville
Country: United States
State or Province: CT
Postal Code: 06085
Organization Name: Cellular Phone Task Force

I am electromagnetic hypersensitive, and I need everything wired. Also, I would think you would consider the health of our country, the citizens and environment and what you have allowed to happen to weaken, disease, and even killl with all the RF etc. The best article that states it well is http://electromagnetichealth.org/electromagnetic-health-blog/smart-grids-dumb-and-dangerous/
I hope you will be intelligent enough to realize we should go fiber, the safe way for the future is fiber optic landlines. Realize money can't buy health for an individual or nation.

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: W
Last Name: George
Mailing Address: 303 West Duane Avenue
City: Sunnyvale
Country: United Kingdom
State or Province: CA
Postal Code: 94085
Organization Name: null

I NEED my landline! Please do not phase out landlines! I am EMF sensitive and I do NOT have other options!

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Public Comments on Developing an Unified Intercarrier Compensation:========

Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Janet
Last Name: Newton
Mailing Address: P.O. Box 117
City: Marshfield
Country: United States
State or Province: VT
Postal Code: 05658
Organization Name: EMR Policy Institute

See attached file(s)

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: John
Last Name: Weigel
Mailing Address: 114 Ryevale Lawns
City: Leixlip
Country: Ireland
State or Province: Leinster
Postal Code: Kildare
Organization Name: Alliance for Irish Radiation Protection

The atmosphere belongs to everyone. Commercial exploitation of the atmosphere for corporate profit at the expense of all living being this is ultimately self-defeating for temporary gain.

Unbridled development of wireless technology is irresponsible because of scientific evidence that wireless microwave technology is powerful and interferes with Nature and biological processes, producing free radicals at the molecular level which ultimately cause cancer in animals.

To deliberately promote the retirement of wired safe technology in favor of unsafe wireless technology by government is antithetical to the purpose of government.

It is an historic fact that looking after those less fortunate is one of the higher attributes of humanity. Conversely, through wireless technology to intentionally create less fortunate and sick people is predatory. For many years the Russian medical establishment recognized "electromagnetic syndrome". More recently, the West has labelled the illness produced by electromagnetism as "hypersensitivity" which is incorrect. Everyone is sensitive biologically to electromagnetism, so more so than others. It is estimated that approximately 10 million Americans are electromagnetically "hypersensitive". To inflict mass pain on multiples of that number across the globe is nothing short of criminal.

Further, it is direct contradiction of the The Nuremberg Code. It is the most important document in the history of the ethics of medical research and the first of its kind to ensure the rights of subjects. The development and imposition of wireless technology constitutes a breach of trust which led the judges after WWII to merge Hippocratic ethics and the protection of human rights into a single code. Wireless violates human rights.

Lawmakers and regulators are looking in the wrong direction. They should be insisting on the safety of the individual over the financial interests of big business. The wireless industry whould be stringently regulated.

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: J
Last Name: B
Mailing Address: 12608 Olympiad Dr
City: Austin
Country: United States
State or Province: TX
Postal Code: 78729
Organization Name: null

The telephone landline system must be maintained. Millions of people depend on this as their only means of communication due to their electromagnetic hypersensitivity. Removing this system removes access to communications from a severely disabled population. The government has been ensuring that rural citizens have access to communications for years, but now it is going to remove that access from the most vulnerable citizens. Not only will these people be left vulnerable and unhealthily isolated, unable to find support, services, or goods without severely endangering their health, but we must maintain cell tower-free areas so these people can have a safe haven from the multitude of illnesses that are triggered by this electrical pollution. I am very lucky that my hypersensitivity is mild and that I can communicate via cell phone for short periods with only minor consequences. However, any lengthy communication is out of the question outside of a land line. I am speaking up for the unfortunate ones who are not so lucky. I have met people who have severe dizziness and confusion rendering them non-functional, upon exposures to cell phone use nearby. Another person I met has instant nausea in the presence of cell phone use that quickly turns to vomiting if not removed from the exposure. These people depend on land lines, and we much ensure that we do nothing to further harm them.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Dr. Howard
Last Name: Bleicher
Mailing Address: 127 E. Alicante Road
City: Santa Fe
Country: United States
State or Province: NM
Postal Code: 87505
Organization Name: null

I would like to place in front of you every one of the unbiased scientific studies, each one of which proves the deadly adverse health effects upon people, animals, insects and the environment. But I will attempt to summarize as best as possible for you, the results from hundreds of reports and studies that were originated and completed by epidemiologists, biological scientists, Medical Doctors, and public health officials from, the USA, Russia, Poland, Sweden, France, Germany, Italy, Australia, Spain, Austria, Canada, England, Ireland, Taiwan, Israel, Brazil and Turkey.

These are not studies funded by commercial interests, but by the countries and the scientists who were and are concerned with the health effects on their respective people and the environments of their countries by the low dose, non ionizing, non thermal radiation emitted from cell towers and their antennae.

These show an increased cancer rate of from 4 to 10 times the national average for people within 500 meters of the cell towers. There appear what are called cancer clusters around cell towers. The studies show genetic damage, breakage of DNA strands, increase diabetes, brainwave changes, rashes, headaches, sleep abnormalities, blood brain barrier permeation, and an increase of people disabled with electrosensitivity. Symptoms of which include, headache, fatigue, tinnitus, dizziness, memory deficits, irregular heart beat, and whole body skin symptoms. The World Health Organization and Sweden have recognized electrosensitivity as a disabling disease. From their studies, 2.5 to 3% of a country?s population have this disabling disease. In the USA this translates to approximately 9,000,000 people who would be unable to live ?anywhere?, since land lines would be replaced by an all encompassing low dose non thermal, non ionizing radiation environment which would produce a major health catastrophe throughout the entire nation!
Who will then be held responsible for this? The FCC? The Telecom Industry?

I would like to place in front of you every one of the unbiased scientific studies, each one of which proves the deadly adverse health effects upon people, animals, insects and the entire New Mexican environment. But being limited for space I will attempt to summarize as best as possible. I have included a few of the many studies and reports available.

Hundreds of planetary studies were originated and completed by epidemiologists, biological scientists, Medical Doctors, and public health officials from, The USA, Russia, Poland, Sweden, France, Germany, Italy, Australia, Spain, Austria, Canada, England, Ireland, Taiwan, Israel, Brazil and Turkey.

These are not studies funded by commercial interests, but by the countries and the scientists who were and are concerned with the health effects on their respective people and the environments of their countries by the low dose radiation emitted from cell towers and their antennae.

These show an increased cancer rate of from 4 to 10 times the national average for people within 500 meters of the cell towers. There appear what are called cancer clusters around cell towers. The studies show genetic damage, breakage of DNA strands, increase diabetes, brainwave changes, rashes, headaches, sleep abnormalities, blood brain barrier permeation, and an increase of people disabled with electrosensitivity. Symptoms of which include, headache, fatigue, tinnitus, dizziness, memory deficits, irregular heart beat, and whole body skin symptoms. The World Health Organization and Sweden have recognized electrosensitivity as a disabling disease. From their studies, 2.5 to 3% of a country's population have this disabling disease. In New Mexico this translates 60,000 people who are unable to live in areas which contain cell towers or do live there with great pain and discomfort.

Children are so much more vulnerable than adults to the low dose non ionizing radiation from cell towers because of the thinner bony plates of their skulls which allows the radiation to more easily penetrate their skulls and permeate their more rapidly developing brains, causing increased brain cancer and increased childhood leukemia. The studies show that the radiation causes the blood platelets to clump leading to the leukemia. Brain cancer and childhood leukemia have recently become the number one disease killer of children.

Telecom companies have had free rein to construct cell towers just about anywhere they want, showing no concern for the health of people. Their one and only goal are the hundreds of billions of dollars and they will say and do anything that will insure that end. No matter what representatives from the telecom industry may say about the need for more radiating cell towers to fill in the so called white spots or gaps in coverage, they do not tell the truth, or in simpler language, they lie! The Telecom industry has known about these devastating health effects before the 1996 Telecom Act and has continually lied and committed fraud in their public statements, having to do with health effects from

cell towers and cell phones.

The USA at this time has not implemented biologically based public and environmental safety limits against these adverse health effects which literally hundreds and hundreds of valid scientific studies have shown the need for. Cell Tower radiation pollutes the environment of NM. Cell tower low dose radiation to date, has never been shown to be safe and the people of New Mexico have to be protected from this ongoing victimization and the untruths circulated by the Telecom Industry.

This is a bipartisan health issue that rises above any political and/or business biases and considerations. We, and that includes the people of New Mexico, members of city and state government, right now, all share in this radiation sauna which will in all probability devastate Santa Fe and the state of New Mexico in the coming weeks and months, since many, many more antennas have obtained permits for their placement in New Mexico, particularly Santa Fe.

I ask the members of the Department of Health and the Department Of The Environment to follow what the state legislature voted for in HM32. To study available literature, studies and reports from the many countries all over the planet, concerning the effects of cell tower & cell phone non-ionizing low dose radiation on human health and the environment. To then, after being fully informed, be able to discuss measures that will insure the health and well being of people, animals and the environment in the state of New Mexico.

I have been researching this issue for the last 10 months and am willing to personally volunteer my time and energies to help the Departments of Health and Environment to meet the November 1, 2011 time.

Sincerely,

Howard H. Bleicher, D.D.S.
127 E. Alicante Road
Santa Fe, NM 87505
505-986-9153
howardb4@comcast.net

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Public Comments on Developing an Unified Intercarrier Compensation:========

Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Warren
Last Name: Black
Mailing Address: 23825 Janbeall Court
City: Clarksburg
Country: United States
State or Province: MD
Postal Code: 20871
Organization Name: null

I rely on ?land line? telephone service; I can not use cell phones because I get headaches if try to use them.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Dorothy
Last Name: Boyes
Mailing Address: 5855 N. Kolb Road, #5101
City: Tucson
Country: United States
State or Province: AZ
Postal Code: 85750
Organization Name: residential

Please do not remove the accessibilty of landline phones. I recently had to stop my cell phone service due to the radion frequency.

Cell phones are not safe for a lot of people who are disabled.

I don't have to wait to see if cell phones are harmful; they are to me and many others that I know personally.

It is also not right to take away something from the market that the people use and need.

Is it constitutional to use such a broad stroke over so many peoples lives?

Landlines are safe and a good back up if cell coverage is lost. Do you really want to cut off communication and have one "UNIFIED" controllor??? I think not.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Lynne
Last Name: Trew
Mailing Address: 360 Montezuma Avenue, #243
City: Santa Fe
Country: United States
State or Province: NM
Postal Code: 87501
Organization Name: Trew Earth Inc

To whom it may concern,

I have been diagnosed and recognized at having sensitivity to electromagnetic fields, specifically to cell phone towers and most elf fields.

The reactions I have is overall body itching, feeling like my body is in a low grade electrical socket, and my hair raises on my head. Many nights I cannot sleep from experiencing restlessness, muscle cramps, and a continual low vibration of my body as if I have stuck my finger into an electrical socket.

Please pay attention to the scientific data that shows the damaging of DNA, the possible causes of cancer, and other health related data that occurs from exposure to elf fields.

Thank you for your consideration,

Lynne Trew

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Erica
Last Name: Streit-Kaplan
Mailing Address: 29 Alden Place
City: Newton
Country: United States
State or Province: MA
Postal Code: 02465
Organization Name: null

To Whom It May Concern;

I am a public health professional and a parent. I love my cell phone but prefer my land line. Research on cell phones is still limited, but the existing information suggests we should be cautious with this new technology. And I certainly don't like my young children being exposed to even small amounts of radiation if I can help it.

Please cotninue to make it possible for me and people like me avoid wireless devices. If the FCC's proposal passes, we will be denied the right to choose a landline.

Do not replace existing landlines with wireless infrastructure until it is proven safe, secure, reliable and affordable!

Thank you.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Jo-Tina
Last Name: DiGennaro
Mailing Address: 8 Robert Road
City: Bayville
Country: United States
State or Province: NY
Postal Code: 11709
Organization Name: null

Please do not proliferate the wireless industry when you have self proclaimed that you cannot ensure the safety of wireless devices. Land lines should be continued as they are proven safe, reliable, efficient, inexpensive, subject to regulation and the most natural (green) way to go because of the unproven safety of these other newer technologies.

Technology is amazing but proliferation without taking into account the health and safety of the human population is irresponsible and a violation of the Govt.'s pledge to provide services for the common good of all citizens of this country.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Catherine
Last Name: Warneski
Mailing Address: 577 oak grove rd
City: FRENCHTOWN
Country: United States
State or Province: NJ
Postal Code: 08825
Organization Name: null

I am opposed to eliminating land phone lines
It is against the 'Americans with disabilities act'
I am sensitive to EMFs which would make it very difficult to use this technology. I am also concerned for people like my father in law who is vision and hearing impaired at 90 years old,
he cannot hear or see well enough to dial a cell phone or a use computer. Someone of his advanced years, disabilities and lack of experience with new technologies could not learn to use them for an emergency. He had tried to use a cell phone, text a screen was up that he could not see or know how to close and he was unable to dial the phone because of the screen, had this been his only mode of communication in an emergency he might have suffered catastrophic injury or worse. These new technologies are not simple to use especially for someone impaired or older. While they seem to be self explanatory to the young, there are not at all to the older.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Gary
Last Name: Gumbel
Mailing Address: 8388 GArden Home Trail
City: Snowflake
Country: United States
State or Province: AZ
Postal Code: 85937
Organization Name: none

I need to use a landline, as a cell phone causes me horrific headaches, dizzyness and spinning in my head. I cannot use a cell except in emergency situations.... if it got down to that. Thank you.

Please Do Not Reply To This Email.

Public Comments on Developing an Unified Intercarrier Compensation:========

Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Nancy
Last Name: Naylor
Mailing Address: 425 Teakwood Lane
City: Springboro
Country: United States
State or Province: OH
Postal Code: 45066
Organization Name: null

Please do not eliminate landlines, nor the subsidies they require to continue functioning. Many American citizens depend on our landlines. The bioinitiative report (http://www.bioinitiative.org/) shows that the radio frequency from cell phones and wi-fi may have biological implications that would make the elimination of landlines unwise. Please put the health and the free choice of Americans first and please do not eliminate the ability of so many of us to use telephone communication safely. Please use the precautionary principle and at least wait until we have ample evidence that cell phones and wi-fi are completely safe for the population, before eliminating any other option.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Betty
Last Name: Tagge
Mailing Address: 7200 E Quincy Ave #109
City: Denver
Country: United States
State or Province: CO
Postal Code: 80237-2250
Organization Name: null

Ellimination of land line telephone systems is a serious problem for individuals who can NOT tolerate wireless tools or devices that use wired broadband. Please do NOT eliminate the land line system. Doing so would severly hamper communication for and isolate this growing population.

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FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Jim
Last Name: Marlowe
Mailing Address: 5701 N. Sheridan rd. apt. 29K
City: Chicago
Country: United States
State or Province: IL
Postal Code: 60660
Organization Name: null

"It has become appalling obvious that our technology has exceeded our humanity."
Albert Einstein

Hello, my name is Jim Marlowe. I am extremely sensitive to wireless technology. If I touch a cell phone that is on - I get a shock. My corded landline telephone is like a lifeline for me. I know other people like myself who depend on landlines for theirr communication needs.
PLEASE keep the switched telephone network for all the people who depend on landlines. Thank you for your time and attention. Sincerely, Jim Marlowe

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Hope
Last Name: Kiah
Mailing Address: 57 Verano Loop
City: Santa Fe
Country: United States
State or Province: NM
Postal Code: 87508
Organization Name: Santa Fe Web Design

Greetings,
I own a web design business and benefit from WIFI. But I am seriously concerned about the health impacts of the spread of wireless technology. Until there is adequate research into the safety of cell towers, I believe that we should be expanding wired technology rather than wireless.
Sincerely,
Hope Kiah

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Joanna
Last Name: Patton
Mailing Address: 130 East 67th Street
City: New York
Country: United States
State or Province: NY
Postal Code: 10065
Organization Name: null

Please do not replace existing landlines with wireless infrastructure until we know more about the consequences
of doing so.

Thank you.

Please Do Not Reply To This Email.

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Michele
Last Name: Hertz
Mailing Address: 62 Euclid Avenue
City: Hastings on Hudson
Country: United States
State or Province: NY
Postal Code: 10706
Organization Name: null

RE: FCC proposal - Developing an Unified Intercarrier Compensation - FCC-2011-0078-0001

Do not do away with telephone land lines. I was injured by the radiation from a "smart" electric meter. I now can not use a cell phone because the radiation from it makes me sick.
I contacted the FCC in March 2010 about the dangers of "smart" meters. I know others have been contacting the FCC for years about this issue. The FCC is ignoring us.
It would be a very dangerous situation if I were to find myself in an emergency and could not call 911 or an ambulance because I could not use a cell phone. I must have a corded land line. That is all I use.

Please Do Not Reply To This Email.

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Legacy Document ID:
RIN:
Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Don
Last Name: Hamilton
Mailing Address: PO Box 67
City: Ocate
Country: United States
State or Province: NM
Postal Code: 87734
Organization Name: null

I am a health care provider. As time goes on and there are more studies available, as well as more experience, we find more and more health issues with wireless networking, cellular telephones, and so on. Additionally, wireless services are less secure than wired. It is imperative that we retain wired communications for those who choose them, not only for health reasons, but also for reasons of security.

Please ask for independent, thorough studies on any new technology before adopting such technology. These newer methods use subtle energies, whose impacts may take months or even years to uncover, unlike coarser toxins like chemicals. We must not hurry here.

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Public Comments on Developing an Unified Intercarrier Compensation:========

Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Dianne
Last Name: Cassidy
Mailing Address: 512 NW 16th St
City: Corvallis
Country: United States
State or Province: OR
Postal Code: 97330
Organization Name: null

Dear Who It May Concern,
Do not allow the dismantling of phone landlines!! It will force all Americans to use cell phones, which are still under investigation as to their safety. As a business owner, I rely on my landline.
Thank you for this opportunity to express my opinion,
Dianne Cassidy

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Title: Developing an Unified Intercarrier Compensation
FR Document Number: 2011-04399
Legacy Document ID:
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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Kim
Last Name: Catania
Mailing Address: 2155 Roland Way
City: Eugene
Country: United States
State or Province: OR
Postal Code: 97401
Organization Name: null

RE: FCC proposal - Developing an Unified Intercarrier Compensation - FCC-2011-0078-0001

Landline service is absolutely essential to many people and must be preserved.

There is a portion of the populace who cannot use wireless technologies due to health constraints, especially those with electromagnetic sensitivities. This prevents them from using the cellular phone system. These people rely exclusively on the landline switched telephone network for voice communication.

Removing landline service would deny these people access to phone service, a fundamental and essential right and resource. This would also constitute a serious violation of the Americans with Disabilities Act (ADA). In light of these facts, it is clear that elimination of landline service should be prohibited.

For a brief review of pertinent information regarding those with environmental sensitivities, please visit the U.S. Architectural and Transportation Barriers Compliance Board (Access Board) at http://www.access-board.gov/research/ieq/intro.cfm

Regards,
Kim Catania
Eugene, Oregon

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Submitter Info:
First Name: Mary Lee
Last Name: Maloney
Mailing Address: 705 Sherman Avenue, #2
City: Evanston
Country: United States
State or Province: IL
Postal Code: 60202
Organization Name: Cell Phone Task Force

I am for keeping a telephone system which allows for line telephones to be maintained. I do not want to have a cell phone or mobile phones in my home. The reason I feel this way is that harmful electromagnetic frequencies have been found to emit from cell and mobile phones. These electromagnetic frequencies effect many areas of the human brain as well as areas of the body. The cerrebelum or "thinking brain" is especially effected.

My friend, Ann Engelstadt, asked me to put her vote in, as well, for keeping the telephone system as it is--allowing line telephones to be used. This is because she has suffered tremendous damage to both her brain and body from the effects of electromagnetic frequencies. The majority of her physical problems began with the installation of the cellular towers in the Chicagoland area. Her body cannot tolerate more EMFs. She needs her line phone!

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Submitter Info:
First Name: Loretta
Last Name: Gruodis
Mailing Address: 4819 A Westwind Drive
City: Mount Airy
Country: United States
State or Province: MD
Postal Code: 21771
Organization Name: null

Land lines are the safest and most reliable form of phone communication. Our family does not use cell phones to communicate...we use all land lines and would like to continue to have the choice to use landlines. They are more secure and do not come with the hazards of wireless technology.

The U.S needs to sit up and pay attention to the emerging scientific data. We become so enamored in our new toys that we leap before looking and the elimination of land lines is a perfect example of that behavior.

Epidemiological Evidence for a Health Risk from Mobile Phone Base Stations:

http://www.brain-surgery.us/Khurana_et_al_IJOEH-Base_Station_RV.pdf

Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays:

http://article.pubs.nrc-cnrc.gc.ca/RPAS/rpv?hm=HInit&journal=er&volume=18&calyLang=eng&afpf=a10-018.pdf

Disturbance of the Immune System...:

http://www.emrnetwork.org/pdfs/PATPHY_621.pdf

Public Health Implications of Wireless Technologies:

http://www.ntia.doc.gov/broadbandgrants/comments/6E05.pdf

Wireless Devices, Standards, and Microwave Radiation in the Education Environment

http://www.vws.org/documents/14.EMFGaryBrowninEducn.pdf

Overview of BioInitiative Report: http://www.youtube.com/watch?v=7tZDor-_co0

Thank you.

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Submitter Info:
First Name: Karl
Last Name: Neiswender
Mailing Address: PO Box 1394
City: San Juan Capistrano
Country: United States
State or Province: CA
Postal Code: 92693
Organization Name: null

I implore you not to dismantle the telephone land line infrastructure in the United States. Doing so would leave thousands of Americans without telephone service. Furthermore, there is a fast growing segment of the population who are becoming sick and otherwise intolerant to the radiation that is produced by cell phones. These people will have no where to go to find refuge if you blanket the entire nation with cell phone radiation. This would become a human rights travesty and leave the FCC vulnerable to law suits.

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Submitter Info:
First Name: Carrie
Last Name: Wiznitzer
Mailing Address: 15 Johns Avenue
City: Medfield
Country: United States
State or Province: MA
Postal Code: 02052
Organization Name: null

I am against the proposal to eliminate landline phones. Every household should have a landline phone for an emergency if nothing else. Also my sister in San Francisco is allergic to cell phones so without the option of having a landline phone she would be "phoneless." And imagine the elderly who don't own and don't want to own a cellphone. Technology is great but lets not get rid of basics here.

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Submitter Info:
First Name: John
Last Name: Sullivan
Mailing Address: 2611 Terrace View
City: McKinleyville
Country: United States
State or Province: CA
Postal Code: 95519
Organization Name: none

Wireless technology is hazardous to human health and destructive to the environment. RF microwave radiation has never been proven safe and never will be. Keep telephones wired and land-based!

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Patricia
Last Name: Schmieg
Mailing Address: 24 Fellsview
City: Medford
Country: United States
State or Province: MA
Postal Code: 02155
Organization Name: null

April 18 is tax day. Many Americans don't know about the deadline to comment on a proposal that drastically affects communication, health, disaster & emergency access. Please extend deadline for comments.

Switched telephone networks must be maintained to give all Americans right to full and healthy communication.

FCC has stated, it does not have the expertise to determine safety standards for exposure to radiofrequency (RF) radiation. No government agency studies the biological effects of continuous exposure to RF radiation from wireless devices and antennas. The FCC's new proposal fails to outline how wireless infrastructure will be monitored and regulated.

Please scrap your plans until you have determined a safe and universally accessible communication system.

Children, people with neurological disabilities, and sensitivity to EMFs are vulnerable to emanations from extended cellphone use.

I can't hear well on a cellphone, and, from the shouted cell conversations around me, neither can most people! This proposal does not meet ADA guidelines for universal communication access for people with total or partial hearing loss.

VOIP protocols are unreliable and easily interrupted. I use broadband cable for Internet. I've gone a week or more without service. Outlying rural areas need safe, reliable service. If power goes out, the
home phone electronics will only run until its backup battery runs
down. Analog telephones get power from the phone line and still work during a blackout.

According to the Access Board, an estimated 3% of the population, or almost 10 million Americans, have electromagnetic sensitivities (www.access-board.gov/research/ieq/intro.cfm). They cannot use wireless technology and have difficulty using computers. They depend on the switched telephone network for voice communication. "Universal Service" is not universal if it excludes 10 million people. Eliminating landlines will leave millions of Americans without even basic telephone service.

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Submitter Info:
First Name: John
Last Name: Branco
Mailing Address: 13 Sisson Hill Lane
City: Westport
Country: United States
State or Province: MA
Postal Code: 02790
Organization Name: null

Hello,

I am aware that FCC-2011-0078-0001 may lead to the eventual demise of landline telephones.

I believe that that would be a travesty for several reasons.

The elderly are much more able to use landline phones and shouldn't have to worry about charging a cell phone. How would a forgetful older person make an emergency phone call with a dead battery in their cell phone?

Also, an increasing number of individuals are now reacting to electromagnetic fields, which cell phones emit much more than landline phones. I believe we should wait until there is conclusive science in place proving that cell phones do not contribute to electromagnetic sensitivities, or other illnesses.

Finally, I truly enjoy having landline phones at home. They provide clearer communications and do not suffer from the signal delays that cell phones exhibit. I have no interest in owning a cell phone.

Thank you,
John Branco

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Submitter Info:
First Name: Kathy
Last Name: Larson
Mailing Address: 228 Summer St
City: Lanesboro
Country: United States
State or Province: MA
Postal Code: 01237
Organization Name: null

Do not replace existing landlines with wireless infrastructure until it is proven safe, secure, reliable and affordable!

Landlines are safe.
Children, people with medical implants, people with Radiofrequency Sickness, and people who don't want to increase their risk of cancer can use only landlines.

Landlines are also more reliableand not dependent oelectricity during long power outages

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Submitter Info:
First Name: Deb
Last Name: Reynolds
Mailing Address: 28 Rolfe Road
City: Windham
Country: United States
State or Province: ME
Postal Code: 04062
Organization Name: null

I understand that the FCC believes that the switched telephone network (i.e. telephone lines and switching centers) is obsolete and should be dismantled. Therefore FCC's policy is to phase out telephone lines during the coming years and replace them with broadband service. In other words, the FCC wants ordinary telephones to be entirely replaced with cell phones and computers (voice over Internet).

I have a compromised immune system and have concerns that ubiquitous wi-fi /radio frequencies all around me will cause more health problems at a time when I'm trying to recover my health. I belong to a support group of local people who are suffering from various immune system dysfunctions and they are researching this issue along with the state-wide installation of smart meters to replace traditional electricity meters.

My doctor told me that he is concerned, saying the extra exposure to electromagnetic fields will certainly affect my health. Since smart meters were installed in my neighborhood i have had shingles.

The U.S. President?s Cancer Panel has reported that ?the true burden of environmentally induced cancers has been grossly underestimated.? The panel pointed to cell phones and other wireless technologies as potential causes of cancer. In its recommendations, the panel stated:
?Methods for long-term monitoring and quantification of electromagnetic energy exposures related to cell phones and wireless technologies are urgently needed given the escalating use of these devices by larger and younger segments of the population and the higher radiofrequencies newer devices produce.?

Dr. Ted Schettler, director of the Science and Environmental Health Network, said: ?... Even if cell phones raise the risk of cancer slightly, so many people are exposed that it could be a large public health burden.?
Sources:
Electromagnetic Health May 6, 2010
President's Cancer Panel 2008-2009 Annual Report (PDF)
New York Times May 6, 2010
World Wire May 7, 2010

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Submitter Info:
First Name: G
Last Name: Eversole
Mailing Address: ---
City: ---
Country: United States
State or Province: WA
Postal Code: 98201
Organization Name: null

I am opposed to ANY regulation that would eliminate telephone land lines.

I live where cellular service is NOT available.

I cannot use wireless as it makes me very ill and this has been medically confirmed.

You do not seem to consider the science or the issues in Rural America.

This is similar to the push for mercury toxic CFL light bulbs.

I take it the telecommunication corps are behind this.

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Submitter Info:
First Name: Dr. Howard
Last Name: Bleicher
Mailing Address: 127 E. Alicante Road
City: Santa Fe
Country: United States
State or Province: NM
Postal Code: 87505
Organization Name: null

Children are so much more vulnerable than adults to the low dose non ionizing radiation from cell towers because of the thinner bony plates of their skulls which allows the radiation to more easily penetrate their skulls and permeate their more rapidly developing brains, causing increased brain cancer and increased childhood leukemia. The studies show that this radiation causes the blood platelets to clump leading to the leukemia. Brain cancer and childhood leukemia have recently become the number one disease killer of children.

Telecom companies have had free rein to construct cell towers just about anywhere they want, showing no concern for the health of people. Their one and only goal are the hundreds of billions of dollars and they will say and do anything that will insure that end. No matter what representatives from the telecom industry may say about the need for more radiating cell towers to fill in the so called white spots or gaps in coverage, they do not tell the truth, or in simpler language, they lie! The Telecom industry has known about these devastating health effects before the 1996 Telecom Act and have continually lied and committed fraud in their public statements, having to do with health effects from cell towers and cell phones.

The USA at this time has not implemented biologically based public and environmental safety limits against these adverse health effects which literally hundreds and hundreds of valid scientific studies have shown the need for. Cell Tower radiation (satellite) pollutes the environment, effecting wildlife, insects and plant life. Cell tower low dose non ionize, non thermal radiation to date, has never been shown to be safe and the people of the USA have to be protected from this ongoing victimization and the untruths circulated by the Telecom Industry.

This is a bipartisan health issue that rises above any political and/or business biases and considerations. All Americans share in this radiation sauna which will in all pr

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Submitter Info:
First Name: Soula
Last Name: Culver
Mailing Address: 1618 Ward St, Apt, A
City: Berkeley
Country: United States
State or Province: CA
Postal Code: 94703
Organization Name: null

See attached file(s)

Do not allow the destruction of the landline phone system. The switched telephone network must be maintained.

You will receive many comments from people such as myself who have electrical sensitivities (aka Radiation Sickness)most of whom cannot use wireless or cordless phones.
But even beyond that, copper lines must be retained -- there are people with electrical sensitivities such that they cannot use digital phone lines. I have corresponded with one who told me: "I cannot use the digital land line services (Time Warner offers this service) as they are very painful."
Universal Service must be maintained, and it is not universal if people cannot use the technologies.

Remember also that landlines are secure and reliable. During natural disasters and power outages, people have to fall back on their landline phones. It could contribute to horrible catastrophes if landlines were eliminated.

Landlines provide the only affordable option for many people. Do not mess with what is working.

Computer calls are difficult to make and the quality is lousy.

In fact, cell phone calls are lousy too. It is an entirely different qualitative experience to have a conversation between two copper landline phones versus struggling to make out what someone on a cellphone is trying to say. Dimensions of communication that can be conveyed easily over landlines are lost.

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Submitter Info:
First Name: Anne
Last Name: Ellinger
Mailing Address: 21 Linwood St.
City: Arlington
Country: United States
State or Province: MA
Postal Code: 02474
Organization Name: null

Please keep land lines! I have cell phones, too, but often don't want to use up my minutes. Plus I have concerns about health effects of using cell phones, so I often prefer land lines. Thanks!

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Diane
Last Name: Schou
Mailing Address: 58 Wesley Chapel Road
City: Green Bank
Country: United States
State or Province: WV
Postal Code: 24944
Organization Name: individual

Please see the attached file.

FCC-2011-0078-0001

1) Thousands of American have a severely disabling condition known as electrical hypersensitivity. Wireless communications are barriers to those of us with this condition. Wireless communication is invisible radiation. Broadband transmissions over power-lines emit frequencies and contaminated electricity that interfere with neurological processes. The emissions were and are invasive and usually are on 24/7. These invisible emissions are harmful and are barriers denying access to electromagnetic radiation sensitive persons.

2) We EMS disabled already are not able to go to places where there are cell towers, wi-fi, cell phones, or other wireless communications. Because of this, access is already limited. It is essential that a network of fixed communications remain and be maintained. Reducing funding for or removing landline or corded telephone technology makes us EVEN MORE isolated and will be denying access to communication via telephone. Access to society, emergency, etc. will be denied.

3) Biological health effects have been withheld from the public. The good research is difficult to obtain. What is obtainable are reports that were funded by industry, selectively manipulated or distorted showing no to little health effects.

4) The latent assumption in this proposal is that wireless technologies are safe. Media attention is always directed to the issues to where mobile phone use is related to cancer. A person severely affected by electromagnetic radiation stated "Cancer is not the worse thing that can happen to you." This is actual.

5) Addressed in the proposal is communication to health care facilities, communication between health care facilities, life-line communication; BUT NO WHERE is there identification of, nor suggestion of, protection for us electromagnetic radiation sensitive or disabled.

6) NO WHERE is there acknowledgement HEALTH CARE EXPENSES MAY LIKELY RISE as people develop symptoms from overexposure to wireless communication or contaminated electricity devices.

7) NO WHERE does this report address the negative effects including health , environment, animals, plants.

8) I continue to become disabled after being exposed to a nearby cell tower and now I remain sensitive to main forms of electricity. Originally, I was injured by invisible, far-reaching emissions from a new cell phone tower, 1/3 mile from my home. Anyone can become sensitized if the right "trigger" alters their protective immune system. After approximately nine months of cell tower emissions permeating my home 24/7, electromagnetic radiation symptoms of injury appeared and increased as I stayed exposed. Later in the first year, symptoms lessened or disappeared when there was no exposure to *that* cell tower *unique frequency emissions*. I now react to other frequencies within four days. Perhaps due to the overexposure of the first frequency and/or accumulation, I now react

to others. I do not want any! Where to go? How to survive? Does America ignore our plea?

9) If the proposers of points with this national broadband plan are unaware of health effects, and disabilities due to electromagnetic radiation, then the proposers are either not knowledgeable enough, they were close minded, or they were deliberately avoiding negative consequences. If the proposers of this document are aware of, have been informed, have been alerted negative health effects and disabilities, possible environmental changes due to electromagnetic radiation, then their actions and judgments in drafting these proposals are criminal! Hiding behind biased or falsified research is wrong. Falsified or biased research funded by the mobile telecom industry does not make the condition disappear.

D. Schou

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Publish Date: 3/2/2011 12:00:00 AM

Submitter Info:
First Name: Katie
Last Name: Singer
Mailing Address: PO Box 6574
City: Santa Fe
Country: United States
State or Province: NM
Postal Code: 87502
Organization Name: null

Because I am sure that you care about your survival and mine, I believe you meant to ask for ideas about how to encourage everyone in our society to eliminate radiation-emitting wireless devices and keep landlines, a technology that's proven safe.

I'm a novelist and I've also written several books about the menstrual cycle and natural family planning. I'm a teacher whose work was featured in a half-hour documentary for American Public Radio. I'm listed in Who's Who of American Women. Since 1997, when a dentist I still dearly love installed four gold crowns over fresh mercury in my mouth, and this created oral galvanism, I've been unable to use a computer or a cell phone or be under fluorescent lights or WiFi without getting extremely sick.

Right now, I'm as employable as a pearl at the ocean's bottom.

I'm like a worker bee looking for a home.

If you eliminate landlines, I will lose my primary means for connecting with people.

Since 2004, I've made annual trips to teach in Amish communities. If you eliminate landlines, you will also eliminate their culture.

I beg you: Please do not radiate this world any more. An increasing number of studies show that wireless technologies cause cancer. The US Fish and Wildlife Service has called on Congress to investigate the relationship between bee colony collapse and telecom equipment. We can't survive without bees. Please do not install more telecom equipment until it's proven safe. Please continue to maintain landlines, a proven technology.

The EMR Policy Institute
A Non-Profit Corporation
www.EMRPolicy.org

Advancing Sound Public Policy
on the Use of Electromagnetic Radiation (EMR)
P. O. Box 117 Marshfield VT 05658
Tel. and FAX : 802-426-3035 E-mail: info@emrpolicy.org

CALL ME RESPONSIBLE:
Learning Federal Rules About Wireless Devices and Health

by Katie Singer
January, 2011

The EMR Policy Institute and Katie Singer encourage free distribution of this essay.
It will be updated as developments require.

Suppose you learned that if certain corporations want to do business, a federal law mandates that your town cannot refuse based on the potential for these corporations to do environmental harm. You can only refuse business if you don't like how a company's equipment looks or if the equipment's appearance decreases property values.

Further, these corporations can sue your city if you take too much time to process their applications to install equipment or if they believe that you took health into account when denying them a permit.

Would you wonder why an industry would lobby for such a law?

Where would you go for proof about the safety of its equipment?

In 1996, Congress passed The Telecommunications Act, our federal statute for telecom services. Section 704 outlines the provisions stated above. Fifteen years later, most of us use cell phones and WiFi. We live, work and go to school near antennas. The Federal Communications Commission (FCC) bases its safety standards for radiation emitted by telecom equipment on engineering needs, not human biology. A national broadband plan grants telecom companies billions of dollars to install more equipment.

No government agency studies the health or environmental impacts of radiation emitted by telecom equipment. No government agency has determined the maximum daily amount of this radiation that babies, children or adults can receive before their health becomes compromised.

> Mike, 42*: My store's landlord has just contracted with a telecom company to install a 55-foot cell tower in my parking lot. I entered the buildings address at www.antennasearch.com and learned that there are already 250 antennas within a four-mile radius. Isn't this enough?*
>
> *When I asked around about the safety of these antennas, I learned about the Telecom Act. Frankly, it shocks me. I don't know if I can give up my cell phone or wifi.*
>
> *I don't know how my business will be affected by this antenna. But I'm ready to look at how telecom equipment affects human health and the environment, even if my landlord and my government are not*. Call me responsible*. I'm ready to learn.*

When did electronics become part of our lives?
Starting in the 1890s and into the 1920s, power lines were installed around the country to provide electricity for lights. Soon, we also had electrically-powered refrigerators, ovens, washing machines, radios, televisions, typewriters and blankets. Computers became common in the 1980s.

From 2005 to 2007, the number of cell phone subscribers in the U.S. increased from 34 million (13% of the population) to 225 million (84% of the population). Worldwide, 4.5 billion people now have mobile service.

While electronics have become essential to every aspect of modern civilization, epidemiologist Samuel Milham, MD, MPH, has observed a connection between electrification and modern diseases - diabetes, heart disease and cancer.

What is electricity?
Lightning is a visible form of electricity. Two hundred years ago, two Italian scientists produced the first human-made electric current, paving the way for electricity to power machines. Electricity can also produce signals that carry information.

Usually, electricity is invisible. Behind walls, cables carry electric current that provides energy for appliances at the flick of a switch. With wireless devices like mobile phones, electromagnetic energy is not confined within cables.

What kind of information do electromagnetic signals carry?
Every organ in the human body gets information about how to function from electromagnetic signals. Your brain, heart, blood, muscles, nerves, kidneys and digestive organs communicate to each other by electromagnetic signals. So do bees, birds, cows, fish, plants and trees.

Electronic devices also require electromagnetic signals to function and to carry data. To operate a mobile phone for example, electromagnetic frequencies (EMFs) send an encoding of a person's voice from the phone to a cell phone antenna, through a network, and then to the phone that receives the call. Corded landlines convert the voice to signals that travel through cables that are designed to confine the electromagnetic energy.

How are electromagnetic frequencies measured?
EMFs are measured in Hertz (Hz). In an electric current, one hertz is a cycle of vibrations that takes place in one second. The more electromagnetic vibrations that occur in one second, the more data can be transmitted. One million vibrations in one second is called a megahertz (MHz). A gigahertz (GHz) is one billion vibrations per second.

What is a microwave?
Electromagnetic frequencies above 300 million cycles per second (300 MHz) and below 300 billion Hertz (300 GHz).

At what frequency do electronic devices operate?

- AM radio uses about 1 MHz to transmit music or talk.
- FM radio uses 88 MHz to 108 MHz.
- Early TV broadcasts used "very high frequency" (VHF) waves, up to 216 MHz. Later, "ultra-high frequency" (UHF) channels used up to 800 MHz.
- Most wireless internet connections and many digital mobile phones use 2.4GHz or higher.
- Current model cordless "DECT" phones use 5.8 or 6.0 GHz.
- New body scanners at airports operate at frequencies above 300 GHz.

> Paula, 22*: In school, I learned that the mind is most restful when it cycles seven times per second. The Earth vibrates at 7.83 Hz, almost eight cycles per second. This field is called the Schumann Resonance. It makes sense that a restful mind vibrates in sync with the Earth. But now we're surrounded by devices that vibrate from fifty or sixty to six billion times per second. How do I deal with this if my goal is a restful mind?*

What is electromagnetic radiation?

When an electrical charge is accelerated, energy is released into space. This emission is called electromagnetic radiation (EMR). EMR carries energy that is usually invisible and that can move through space and penetrate most non-metal objects. Mobile phones use EMR to create an invisible wave that can carry your voice or other data. X-ray machines use such high frequencies that they can even penetrate most metals. Microwave ovens use EMR to heat food. Whenever moisture is present, such as when passing through a person, some radiation is absorbed, creating heat or molecular movement.

How did our government determine that cell phones are safe?

The Food and Drug Administration (FDA) decided that cell phones are safe since the body temperature of a six-foot, 200 pound man using a cell phone for six minutes does not change significantly. The FDA has not conducted studies about how mobile phones, WiFi, antennas and wireless utility meters (alone or in combination) affect babies, children, pregnant women, the elderly, the infirm, or people with medical implants. Some scientists point to the non-thermal effects of using a cell phone:

- After 20 minutes of use, double-strands of DNA break into fragments. If the body's repair systems can't keep up with these breaks, cancer and birth defects can result.[1]
- Cancer rates increase, especially when people begin using mobile phones as children and hen anyone uses one for 30 minutes or more per day for ten years or longer.[2, 3]
- After two hours of use, the blood-brain barrier begins to leak, allowing neurotoxins in food or from the environment (air or water) to affect brain and nerves, eventually leading to brain cell death.[4]

Didn't the World Health Organization report that evidence of harm from cell phone use was not convincing?
Yes. However, the report was authored by Michael Repacholi, an industry consultant who received hundreds of thousands of dollars from corporations with vested interests.[5]

Some city planners claim that radiation emitted from WiMax is much too weak to affect human health. Is that true?
In *Dirty Electricity*, epidemiologist Samuel Milham MD MPH Writes, "When industry apologists say that fields are too weak to cause biological effects, I point them to any number of electro-therapeutic devices, such as pulsed high-frequency field generators that are used to accelerate the healing of bone fractures. Anything that can stimulate cell division and growth is a potential carcinogen." (*http://sammilham.com/contact.shtm*)

How does WiFi impact health?
According to environmental consultant Stan Hartman, having a WiFi antenna in a router on your desk gives you about the same amount of radiation that you'd get 30 meters or less from a typical cell phone antenna.

In isolated human cells, WiFi-like signals can activate the "cell suicide" response.[6]

Are trees affected by WiFi?
Trees in areas with high WiFi activity have been found to suffer from bleeding, fissures in their bark, the death of parts of leaves, and abnormal growth. In the Netherlands, 70% of urban ash trees suffer from radiation sickness, including a "lead-like shine" on their leaves, indicating the leaves' oncoming death. In 2005, only 10% of ash trees suffered radiation sickness.[7]

Is there any relationship between mobile phones, antennas and bee colony collapse?
In India, a study conducted by Dr. Sainuddin Pattazhy shows that EMR emitted by antennas cripples the "navigational skills" of worker bees who leave their colonies to collect nectar from flowers. When a mobile phone was kept near a beehive, the worker bees did not return, and the colony collapsed within ten days.[8]

How does living near a mobile phone base station (also called a cell tower or cell antenna) affect human health?
Studies find that people living within 300 meters of a base station experience fatigue, headache, sleep disruption, irritability, depression, decreased libido, memory loss, dizziness, nausea, loss of appetite, visual disruptions and overall discomfort.[9]

> David Carpenter, MD, Director of the Institute for Health and the Environment at SUNY Albany: *A growing body of evidence shows that wireless devices harm health, including when radiation from these devices does not cause body tissue to heat. Prolonged exposure to radiofrequency radiation increases the risk of cancer. New studies show that children are much more vulnerable than adults. I am particularly concerned about this, given that children are now regular users of wireless devices.*

Leah Morton, MD, doctor of family medicine since 1979: *My patients frequently report that their health worsened when they got a cell phone or WiFi, or an antenna or a wireless utility meter was installed near their home, school or workplace. They need to drastically reduce their exposure to radiation, but because of The Telecom Act, that's often not possible.*

If our health depends on looking squarely at scientific evidence, then we need to revise the Telecom Act so that health can be considered in relation to telecom equipment. The FCC must change its radiation exposure standards to comply with The BioInitiative Report. We need radiation levels tested and reported regularly to the public. We need more publicly-funded studies about how using wireless devices and residing near an antenna and/or with a wireless utility meter on your home affect sleep, memory, blood pressure, attention spans, anxiety, depression, addictive behavior and fertility. We need studies about the combined effects of pesticides and other neurotoxins and microwave radiation. We need studies about how wireless devices affect people with metal dental work, pacemakers and other implanted medical devices.

How do I know if my health is affected by wireless devices?
Some people smoke several packs of cigarettes every day and never get sick. Some people get lung cancer or other diseases from second-hand smoke. Likewise, people respond differently to EMR. People who live and work near antennas, use mobile phones and WiFi and have a wireless utility meter on their home are exposed to different amounts of radiation than people who use only corded phones, have no WiFi and live and work far from an antenna. Every person arrives at the threshold of over-exposure to microwave radiation uniquely. Over-exposure to radiation creates Radio Frequency Sickness. Symptoms include disturbed sleep, ear ringing, headaches, dizziness, nausea, heart arrhythmia, memory loss, altered sugar metabolism, stroke, skin rashes, extreme agitation, and other reactions.

Can I get Radio Frequency Sickness if I don't use wireless technologies?
Yes. Using contemporary TVs, computers, printers and energy-saving washing machines, compact fluorescent bulbs and/or other electronics in a house or building causes "dirty power," where radio waves pulse on the electrical wiring. Occupants of such buildings can experience Radio Frequency Sickness. Wireless utility meters can also create dirty power and Radio Frequency Sickness. (See "Electro-Shocker" by Michael Segel in Prevention's January, 2010 issue.)

Michele, 52*: I had good health, a cell phone and WiFi until September, 2009. I work at home, but starting that month, I couldn't focus enough to work. I couldn't remember words or where I'd put things. Every night, I woke up agitated several times. I was always on high alert. Privately, I wondered if I had Alzheimer's.*

In February, 2010, during a winter storm, our electricity kept going off and on. I got a high-pitched, painful ring in my right ear. I started having heart palpitations and nightmares, and my other symptoms got stronger. I wondered if something was wrong with our electricity. My electrician wondered if Con Edison had installed a wireless meter on our home. They had--in June, 2009.

After several phone calls and a letter from my doctor, Con Ed removed the Smart Meter they had installed on our house. Within days, the pulsing and loud buzzing quieted, and my thinking got clear again. But now, if I'm near a cell phone or WiFi or if I drive by a cell tower, I get sharp pain in my ear and pressure in my head.

I consider the Smart Meter my tipping point. Unfortunately, my neighborhood is still flooded with these meters. Each one transmits pulses of microwave radiation 24/7. When I requested studies about the meters' effects on human health, Con Edison told me I'd need a subpoena.

I want to continue living in my home. Even with teenagers in the house, I've been able to eliminate wireless devices inside. How can I decrease my exposure to microwave radiation that comes from antennas and my neighbors' Smart Meters?

The federal government needs to fund research about the health effects of these meters. States that have not yet installed them need to wait until Smart Meters are proven harmless.

When in human history have people noticed that their behavior was destructive--and then changed their behavior?

Hundreds of years ago, when Native American farmers realized that they depleted their soil when they planted the same crop in the same soil year after year, they began to rotate planting beans, corn and squash. Nutrients in their soil--and the vegetables--were replenished.

Around 1900, in New York City, orphaned babies were fed well and kept warm in orphanages. But many of them died. When a caretaker realized that the babies also needed to be held and lovingly touched, the babies thrived.

In the 1930s, men and women whose lives had become unmanageable because of alcoholism began meeting to share their experiences while they struggled to get sober and keep sober. They wrote the Twelve Steps and formed Alcoholics Anonymous.

In 1989, after the Soviet Union broke up, Cuba lost its oil supply. Suddenly, gas wasn't available even for trucks that transported food. The government bought three million bikes and turned available land into small farms. Scientists developed bio-dynamic fertilizers and pesticides that were not petroleum-based. Communities were strengthened by neighborhood farmers' markets, public transportation and sharing TVs.

When toxic waste from factories and petroleum-based farms made key waterways undrinkable, some people developed mycorestoration: growing mushrooms that eat sludge. The water becomes drinkable again.

Have any governments or professional organizations banned or warned against wireless devices?

- In official comments to the FCC about guidelines for evaluation of electromagnetic effects of radio frequency radiation (FCC Docket ET 93-62, November 9, 1993), The Environmental Protection Agency found that the FCC's exposure standards are "seriously flawed." www.emrpolicy.org
- The Food and Drug Administration commented to the FCC on November 10, 1993 that "FCC's rules do not address the issue of long-term, chronic exposure to radiofrequency fields." www.emrpolicy.org Exhibit 46 p. 410.
- In 2004, the International Association of Fire Fighters declared that it opposes communication antennas on fire stations. www.emrpolicy.org
- The government of Frankfurt, Germany states that it will not install WiFi in its schools until it has been shown to be harmless. www.magdahavas.com/wordpress/wp-content/uploads/2010/09/German_Swiss_Wifi_In-Schools_Warn.pdf p.5

- In 2007, The European Environmental Agency, Europe's top environmental watchdog, calls for immediate action to reduce exposure to radiation from WiFi, mobile phones and their masts. http:// www.eea.europa.eu/highlights/radiation-risk-from-everyday-devices-assessed
- In 2008, The International Commission on Electromagnetic Safety (comprised of scientists from 16 nations) recommends limiting cell phone use by children, teenagers, pregnant women and the elderly. www.icems.eu/resolution.htm
- The U.S. Fish and Wildlife Service urges Congress to investigate the potential relationship between wireless devices and bee colony collapse in May, 2009. http://electromagnetichealth.org/electromagnetichealth-blog/emf-and-warnke-report-on-bees-birds-and-mankind/
- In 2010, municipalities in California, Hawaii, Maine and Maryland have passed resolutions creating moratoriums on Smart Meters. For updates, check www.emfsafetynetwork.org or www.magdahavas.com/2010/12/03/smart-meter-installation-challenged/

Jay: *I run a small city's land use department. Recently, a telecom company proposed installing an antenna in a church steeple here. The church houses a nursery school. Parents do not want this antenna near their children. As a public servant whose job is to uphold land use codes, my choice is between permitting the antenna and a lawsuit from the telecom company for non-compliance, which they will surely win.*

As I see it, concerned citizens need to petition their Congressional reps to revise Section 704 of The Telecom Act so that health concerns can be considered when a telecom company wants to install equipment.

REALISTICALLY, WHAT CAN I DO?

1. Reduce your exposure to EMR:

- Turn your WiFi off at night. If you're not sure how to do this, unplug your computer and your modem.
- Go back to a corded landline. Go back to cabled internet access. Don't use your mobile phone for a week, and see if your health or sleep changes.
- Quit fluorescent lights. While they save energy, fluorescent lights create dirty electricity. Also, fluorescent bulbs are made with mercury. They're highly toxic if broken or not disposed of at a special recycling facility. Go back to incandescent bulbs.
- Unplug the electronic devices in and near your bedroom while you sleep. Don’t just turn off your TV, computer, and alarm clock. Unplug them.
- Eliminate baby monitors, which commonly transmit in microwave range. Switch to a wired intercom.
- Avoid using and replace dimmer switches.